PROGRESS REPORT NUMBER SEVENTEEN

STATE OF MICHIGAN

DEPARTMENT OF CONSERVATION
Gerald E. Eddy, Director

GEOLOGICAL SURVEY DIVISION
William L. Daoust, State Geologist

RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF CHIPPEWA COUNTY, MICHIGAN

By

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Prepared cooperatively by the
United States Department of the Interior
Geological Survey

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INTRODUCTION

Purpose and Scope of Study

A ground-water reconnaissance of the eastern part of the Northern Peninsula on a county unit basis was begun in 1955 as part of the continuing cooperative agreement between the Michigan Department of Conservation and the U. S. Geological Survey. The objective of the reconnaissance is to determine the general occurrence, availability, quantity, and quality of ground water in the study area. To make the results available to the public with the least possible delay, progress reports are to be released upon completion of each reconnaissance study of an appropriate areal unit. This report is the first of the series of reconnaissance reports, and it summarizes the ground-water data obtained in Chippewa County during the initial phase of the investigation. The data are presented in this manner primarily to aid well drillers, contractors, industrialists, farmers, and the public at large in evaluating the ground-water resources of any given area of Chippewa County. A summary description of the major lithologic units is given, which may have application in future explorations for water or other mineral resources.

Cooperative ground-water investigations by the U. S. Geological Survey in Michigan are directed jointly by A. N. Sayre, Chief of the Ground Water Branch, U.S. Geological Survey, Washington, D. C., and W. L. Daoust, State Geologist, Michigan Department of Conservation, Lansing, Mich., and are under the direct supervision of Morris Deutsch, who succeeded J. G. Ferris, of the Federal Survey, in Lansing.

Previous Investigations

Various phases of the geology and hydrology of this area are described in numerous reports of detailed and reconnaissance investigations made in the Northern Peninsula of Michigan since 1821. An investigation of flowing-well districts in the eastern end of the Northern Peninsula was made by Frank Leverett (1906). A detailed investigation of the stratigraphy and glacial features of the county was made by W. A. VerWiebe (1928). In 1949, a reconnaissance of the water resources in the eastern end of the peninsula with reference to the probable effect on ground-water levels of a Lake Superior-level canal through the peninsula was made by J. G. Ferris, L. A. Wood, and E. A. Moulder of the U. S. Geological Survey. Many of the data used in this report were collected during that survey. Pertinent data contained in several reports listed in the bibliography (p. 52) were used freely as source material for this project, and appropriate references to them are made in the text.

Acknowledgment

Special thanks are given to the many well drillers and residents of Chippewa County and to the Federal, State, and county agencies whose wholehearted cooperation made this report possible. Appreciation is expressed also to personnel of the Michigan Geological Survey who furnished much valuable advice and assistance.

Well-Numbering System

The well-numbering system used in the report indicates the location of the wells within the rectangular subdivisions of the public lands, with reference to the Michigan meridian and base line. The first two segments of a well number designate the township and range; the third segment designates the section and the number assigned to each well within the section. Thus, well 44N 2W 8-3 is well number 3 in section 8, Township 44 North, Range 2 West. Numbers formerly assigned to wells and test borings included in this report are listed in tables 2 and 3.

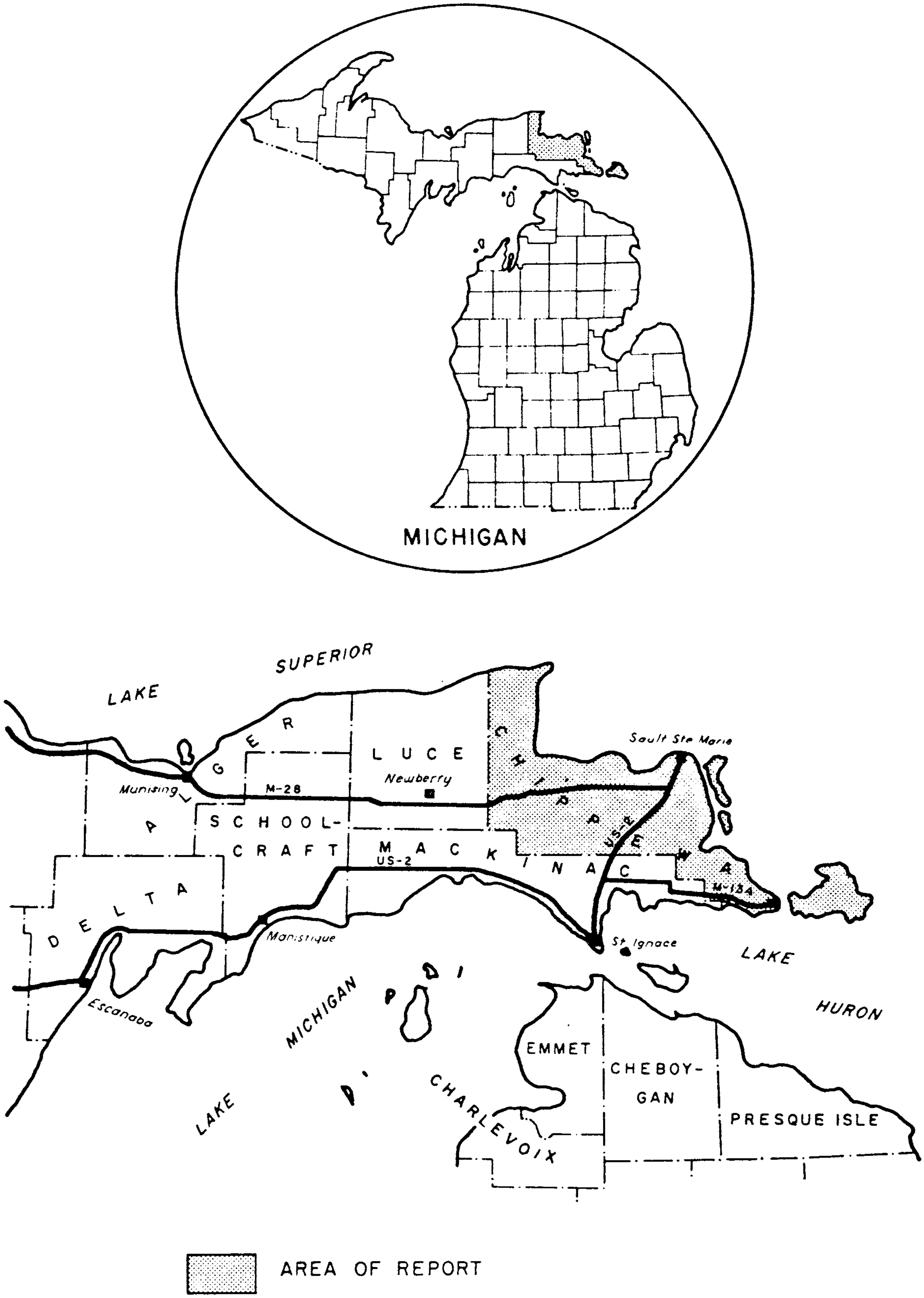


FIGURE 1.—Index map showing location of Chippewa County, Mich.

GEOGRAPHY

Location and Extent of Chippewa County

Chippewa County is at the eastern end of the Northern Peninsula of Michigan (fig 1). The county, including Sugar, Neebish, and Drummond Islands and other smaller offshore islands (pl. 1), has an area of about 1,600 square miles. Of irregular shape, it spans a distance of about 100 airline miles from its northwestern corner on the Lake Superior shore to the eastern end of Drummond Island. Including the islands, the county has a shoreline length of almost 400 miles, of which about 180 miles is mainland shoreline. The international boundary with Canada trends in a southeasterly direction and is drawn through a series of waterways including Lake Superior, St. Marys River, and Lake Huron. Sault Ste. Marie, the county seat, is on the south bank of the St. Marys River directly opposite the city of Sault Ste. Marie, Ontario.

Population

The population of Chippewa County in 1953 was 30,010, compared with 29,206 in 1950 and 27,807 in 1940, as reported by the Bureau of the Census. Commercial and industrial expansion in the Northern Peninsula, with an attendant increase in the rate of population growth, is anticipated after completion of the St. Lawrence Seaway Project and the Straits of Mackinac Bridge. Sault Ste. Marie, the largest city in the county, had an estimated population of 18,500 in 1953. The countywide population density is about 19 persons per square mile, but if the urban areas are excepted, this figure is reduced to about 6 per square mile.

Economic Development

Agriculture

The larger tracts of agricultural land are in the eastern part of the county in the Sault Ste. Marie and Rudyard-Pickford areas. In 1949 there were about 1,000 farms averaging about 162 acres in size. The principal farm products are beef cattle, dairy products, and hay.

Industry

The industries of the county are based on the timber, agricultural, mineral, and water resources of the area. The timber industries include woodworking and furniture manufacturing, the production of pulpwood, posts, and several kinds of lumber. The agricultural industries include dairies, meat-processing plants, and leather industries. The mineral industries are primarily quarrying of dolomite, used in the production of flux, road metal, and aggregate. Industries related to water resources include fisheries, recreation and resorts, generation of electricity, production of calcium carbide, which depends upon a ready source of electricity, and maintenance and operation of the Soo Locks and St. Marys River waterway.

Recreation

The many inland lakes and streams, the beach frontage along Lake Superior, Lake Huron, and the St. Marys River; the extensive woodlands; the excellent hunting and fishing; the Soo Locks; the cool summer climate; and one of the lowest pollen counts in the State make Chippewa County an important recreational area.

Transportation

Chippewa County is served by two railroads. The Duluth, South Shore and Atlantic Railroad connects Sault Ste. Marie with St. Ignace and with cities and towns on the south shore of Lake Superior. The Minneapolis, St. Paul and Sault Ste. Marie Railroad connects the cities along the north shore of Lake Michigan and Sault Ste. Marie with principal cities in the Midwest. A railroad bridge across the St. Marys River at Sault Ste. Marie connects the Northern Peninsula with Canada.

One Federal highway and several major State highways serve the area (pl. 1). Auto ferry service is provided to Neebish, Sugar, and Drummond Islands, and to Canada at Sault Ste. Marie.

The St. Marys River and the Soo Locks, which connect Lake Superior to the other Great Lakes, is the busiest waterway in the world. With completion of the St. Lawrence Seaway Project, traffic presumably will increase. The Chicago, Duluth, and Georgian Bay Transit Co. and the Owen Sound Transportation Co. Ltd., provide intercounty, interstate, and international transit service.

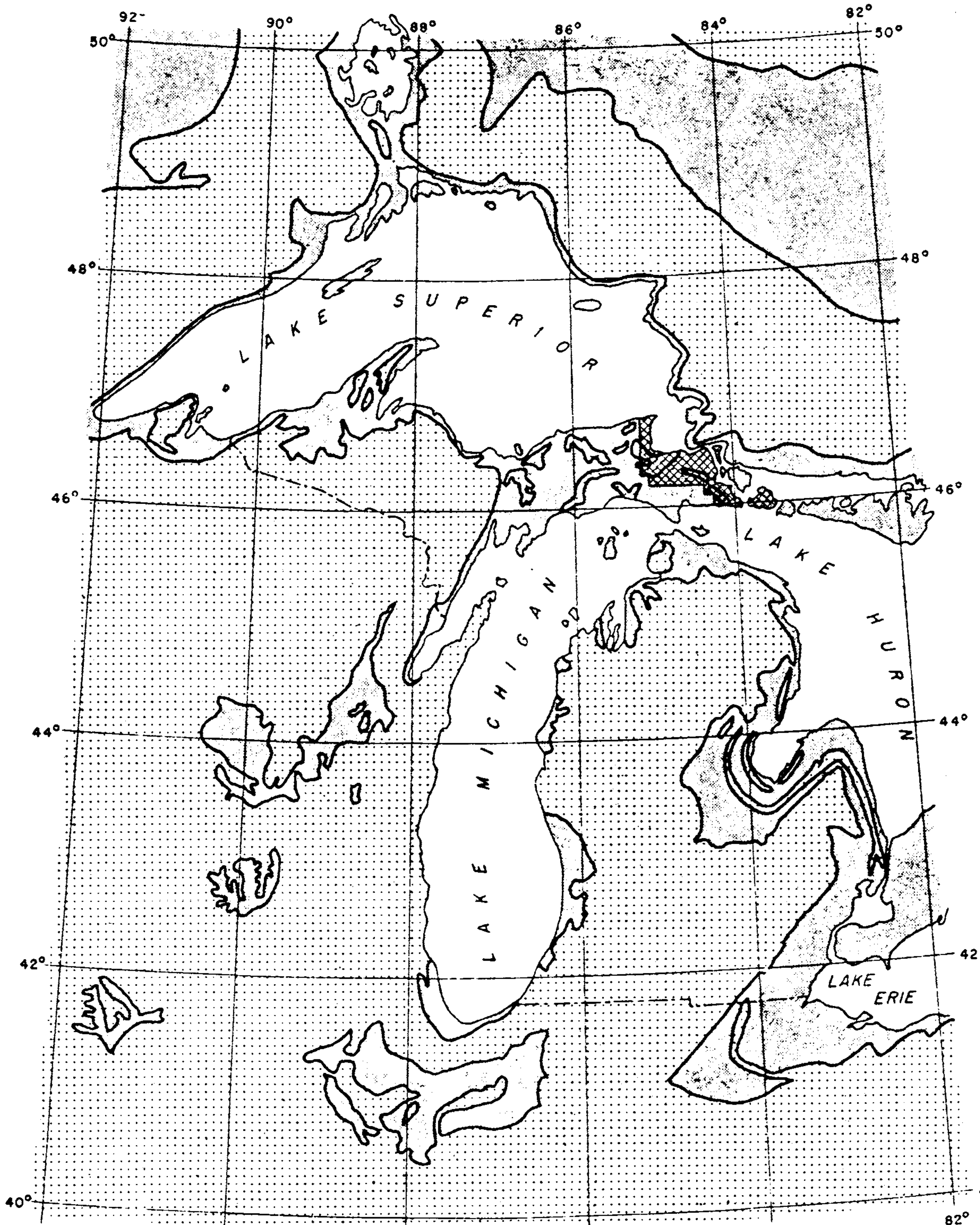
Capital and Trans-Canada Airlines provide air transportation for the county through the airport at Kinross.

Physiography

Chippewa County lies in the glaciated area formerly covered by the waters of glacial Lake Algonquin (fig 2), which was an earlier stage of the present upper Great Lakes system. Deposition in and erosion by the waters of glacial Lake Algonquin and the post-Algonquin non-glacial lakes Nipissing and Algomah (?) produced or altered the physiographic features of the county. The main physiographic units of the county are the lake plains, formed by the deposits of glacial-lake sediments; the morainal highlands, which were modified by lake erosion and deposition; and the Niagara cuesta. The relief of the Niagara cuesta was subdued and the Black River cuesta (pl. 4) was buried by glacial and glacial-lake sediments.

The Niagara cuesta, formed by limestones and dolomites of Early and Middle Silurian age, extends in a broad arc from Wisconsin across the Northern Peninsula and Southern Ontario to New York State. This cuesta, the so-called "backbone" of the Northern Peninsula, forms one of the major highland areas in Chippewa County. The north face of the cuesta (Niagara escarpment) marks the northernmost extent of rocks of Niagaran age in the Michigan Basin. DeTour Passage, which separates Drummond Island from the mainland, and the Pine River are deeply incised into the cuesta.

Most of the western part of the county is an upland formed by a series of moraines (glacial-drift hills) and associated glacial deposits. The upland relief, however, is slight, as the waters of glacial Lake Algonquin leveled the area by eroding the moraines and depositing sediment in the depressions. The areas between and adjacent to the moraines are plains underlain by clayey and sandy lake and



Area covered by lake sediments

Chippewa County, Michigan

Figure 2.--Map of the Upper Great Lakes region showing areas of sediment deposition in glacial Lake Algonquin and other extinct glacial lakes. (After Geol. Soc. America, 1949.)

glacial-outwash deposits. Moraines in this part of the county are poorly drained, and extensive swamps are located in depressions in the center of the highland and along its edges.

The Kinross moraine (Leverett, 1929) and associated deposits form the only other major highland in the eastern half of the county. This morainic highland probably is an extension of the morainic highland in the western part of the county. It extends southeastward from a point a few miles west of Kinross, across the highland formed by the Niagara cuesta, to Lake Huron a few miles west of DeTour (pl. 3). Other small morainic highlands are in the northeastern part of the county, including a long gravel ridge west of US 2 near Sault Ste. Marie. Elsewhere in the eastern part of the county, the predominant surface features are flat, gently sloping lake plains and till plains, which have been somewhat dissected by streams. This eastern area is poorly drained and contains extensive swamp areas. Bars, beaches, wave-cut shorelines, dune areas, and other minor features associated with glacial Lake Algonquin and post-Algonquin lakes are scattered throughout the county.

Relief

Maximum topographic relief in the county is about 510 feet, between the highest point at McNearny Lake tower (sec. 33, T. 47 N., R. 5 W.), at an elevation of 1,090 feet above mean sea level, and the Lake Huron shoreline, which is at an elevation of about 583 feet (pl. 1). The most prominent relief feature is Mission Hill in T. 47 N., R. 3 W., (elev. 1,045) which is 440 feet above and less than 1 mile distant from Lake Superior. The morainic highland in the western part of the county ranges in altitude from about 800 to more than 1,000 feet. The highest part of the Niagara cuesta is in the western part of the county, where it reaches altitudes exceeding 800 feet. The highland at Kinross, and Larke Hill near Sault Ste. Marie, have altitudes of about 800 feet.

The plains of glacial Lake Algonquin in the eastern part of the county are at an altitude of about 700 feet near Sault Ste. Marie and the Kinross highland, and slope gradually to the bluff marking the shoreline of ancient Lake Nipissing (pl. 3). Streams are entrenched about 40 feet into lake plains above the Nipissing shoreline. The bluff along the Nipissing shoreline is about 40 feet high in the eastern part of the county, although it is generally higher in some places and indistinct elsewhere. Lake plains below the Nipissing shoreline have little relief and slope gradually to Lake Superior and to the St. Mary's River.

Drainage

Chippewa County is drained by a number of major streams, which have a total length of nearly 800 miles and flow into the Great Lakes and associated bodies of water (fig 3). The Betsy and Tahquamenon Rivers flow into Whitefish Bay of Lake Superior. The Waiska River empties into the upper reach of the St. Marys River. The Charlotte, Munuscong, and Little Munuscong Rivers flow eastward into Munuscong Lake. The Pine and Carp Rivers flow southward into Lake Huron. Numerous small streams flow directly to the waters of the Great Lakes system. Natural drainage in much of the county, however, is in an early stage of development, as shown by the 169 inland lakes and the numerous swamps. Peat deposits in the area provide further evidence of poor drainage during and after the glacial epoch.

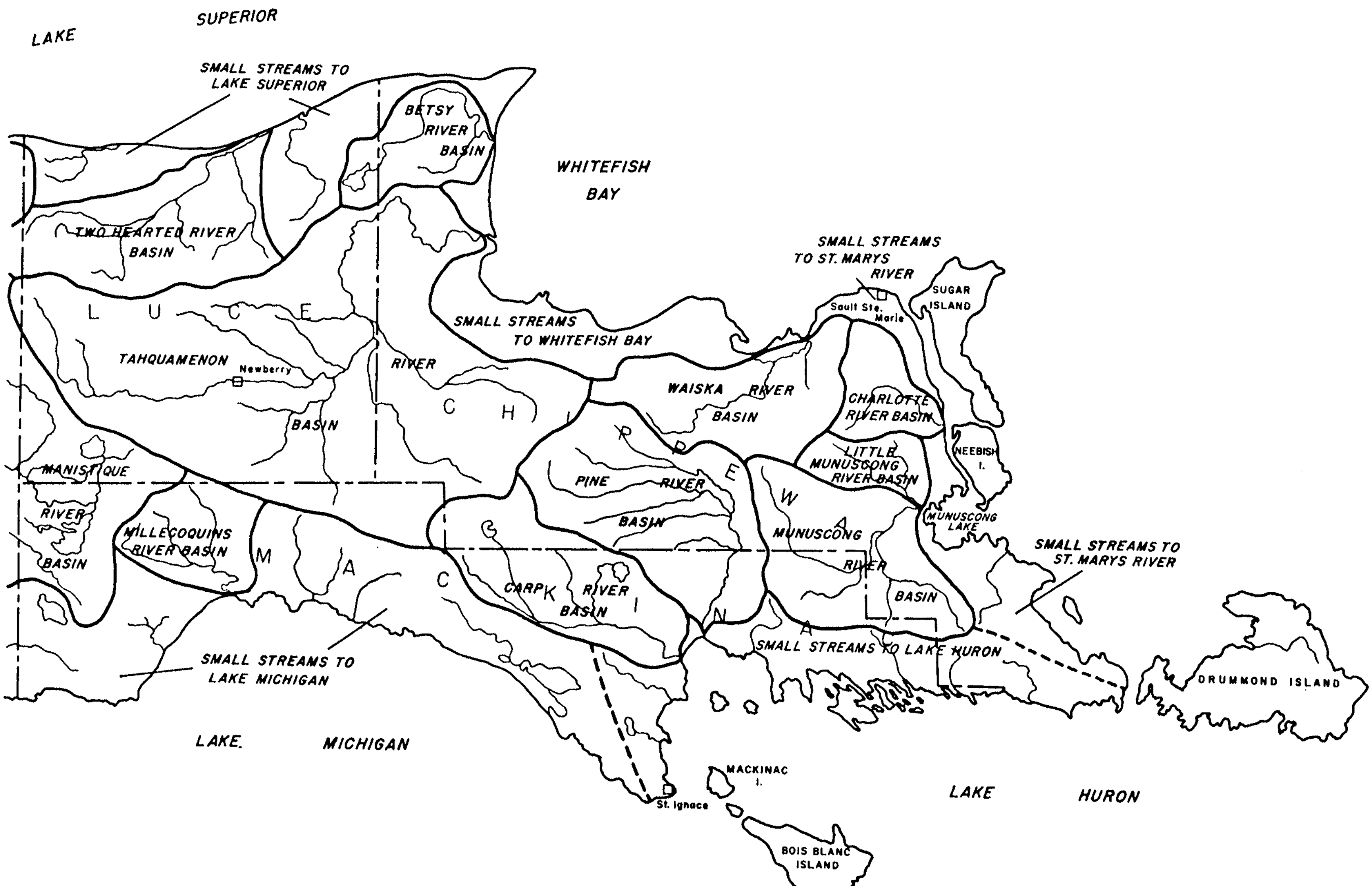


FIGURE 3.—Map of Chippewa, Mackinac, and Luce Counties showing major drainage basins and drainage areas tributary to the Great Lakes system.

Climate

Temperature in Chippewa County is moderate compared with other interior continental areas in the same latitude. Ranges in temperature are decreased by the Great Lakes, which have a warming influence in winter and a cooling effect in summer. The lakes also provide a source of moisture for precipitation in the area.

Annual precipitation, part of which is snowfall, ranges locally from 28 to 34 inches. The cumulative depth of the snowfall ranges from 73 to 116 inches per year. The mean countywide temperature is about 40°F. At Sault Ste. Marie, records of the period 1921-50 indicate an average annual precipitation of 30.2 inches and an average annual temperature of 39.3°F. The average date of the last killing frost in the spring is May 16 and of the first in the fall is September 30. The period from May 21 to October 14 is normally frost free at Whitefish Point on the Lake Superior shore.

Much of the precipitation in Chippewa County is returned directly to the atmosphere by evaporation. Evaporation is controlled by temperature, humidity, solar radiation, and wind velocity. The average evaporation recorded by the U. S. Weather Bureau at the Germfask Wildlife Refuge in Schoolcraft County during the period June through October is 21.63 inches. The numerous lakes and extensive wetland areas in the county (pl. 6) suggest that the total loss of water by evaporation is a significant percentage of the total precipitation.

Table 1.--Lithology and hydrology of the rocks underlying Chippewa County.

AGE	LITHOLOGY	THICK-NESS (feet)	HYDROLOGY	NAMES USED BY MICHIGAN GEOLOGICAL SURVEY: SERIES	GROUP	FORMATION
PLEISTOCENE (Wisconsin)	GLACIAL DRIFT Clay, sand, gravel and boulder till, principally water-laid; stratified sand and gravel outwash; stratified clay, silt, and sand lake deposits; sand and gravel beach deposits; windblown sand.	0 to 400+	Most important aquifer in the county. Best yields from sand and gravel outwash deposits. Moderate yields from morainal sand and gravel deposits and from sand and gravel lenses intercalated with lake clay and silt. Small yields might be obtained from properly constructed wells tapping fine sand and silt lake deposits. Poor yields from till. Layers of till and lake clay are confining beds in artesian systems.	GLACIAL DRIFT (Wisconsin)		
MIDDLE SILURIAN	LIMESTONE AND DOLOMITE Hard, resistant layers of varicolored, but predominantly blue-gray, limestone and dolomite, including several cherty beds. Gypsiferous, calcareous, and dolomitic shale members near the base of the system.	500+	Permeable in fractured and weathered zones exposed at the surface. Permeable where solution openings have developed along fractures and bedding planes in drift-contact area and in some of the deeper seated limestone layers.	NIAGARAN	LOCKPORT	ENGADINE
					CLINTON	MANISTIQUE BURNT BLUFF
EARLY SILURIAN			Poor yields in shale members and in deep-seated dolomite layers.		CATARACT	MAYVILLE CABOT HEAD MANITOULIN
LATE ORDOVICIAN	LIMESTONE AND DOLOMITE Dark-gray and brown limestone and dolomite layers, locally including some shaly units.	240+	Locally permeable where solution openings have been formed along fractures and bedding planes in areas where directly covered by glacial drift. Poor yields where overlain by shale.	CINCINNATIAN	RICHMOND	QUEENSTOWN? BIG HILL STONINGTON BILLS CREEK
	SHALE Black bituminous and gray dolomitic shales. Includes some shaly dolomite.	250±	Permeability low. Will not yield significant amounts of water to wells.		MAYSVILLE	LORRAINE? UTICA? COLLINGWOOD
MIDDLE ORDOVICIAN	LIMESTONE AND DOLOMITE Blue, blue-gray, brown, and buff to white limestone and dolomite. Hard and resistant. Some layers are quite sandy and porous.	210±	Locally yields water to wells penetrating solution openings along fractures and bedding planes or sandy beds. Some openings filled with permeable unconsolidated sediments. Generally will not yield water of good quality where overlain by younger Paleozoic rocks. "Sulfur water" encountered from top of series in Rudyard area.		TRENTON and BLACK RIVER	TRENTON and BLACK RIVER
EARLY ORDOVICIAN and LATE CAMBRIAN	SANDSTONE AND DOLOMITE White and gray, fine- to coarse-grained sandstones and some hard, resistant layers of dolomitic sandstone and sandy dolomite.	180 to 600	Important aquifer in the Northern Peninsula. Sandstone yields moderate amounts of water to wells. Dolomitic layers less permeable or relatively impermeable.		HERMANSVILLE	
				LAKE SUPERIOR SANDSTONE	MUNISING	
CAMBRIAN	SANDSTONE Cross-bedded red, pink, and white sandstones with layers of red and gray shale. Locally friable, elsewhere hard and resistant.	120 to 1300+	Generally yields small to moderate supplies of water to wells. Localized zones of low permeability. Important aquifer in northeastern part of county where sandstone is mantled by drift. Locally, water is moderately to highly mineralized.			JACOBSVILLE
PRECAMBRIAN	METAMORPHIC AND IGNEOUS ROCKS	?	Too deep to permit economical drilling for water. Permeability presumed low.	PRECAMBRIAN UNDIFFERENTIATED		

GEOLOGY

Chippewa County is underlain by several sedimentary rock units of Paleozoic age, which lie on Precambrian metamorphic and igneous rocks and are mantled by unconsolidated sediments of Pleistocene glacial and glacial-lake origin. The areal distribution of the formations of consolidated rock is shown in plate 2 and the surficial deposits are shown in plate 3. The lithology and hydrology of the various formations are outlined in table 1 and are described in the section on Ground Water.

Summary of Geologic History

During the Paleozoic era the lowland area now called the Michigan basin was invaded by a succession of warm, shallow seas in which vast quantities of sediment were deposited. The sediments, which included clastic, organic, and chemical deposits, subsequently were lithified to form the limestones, dolomites, sandstones, shales, evaporites (salt deposits), and other consolidated rocks of the Michigan basin. The rocks deposited in Cambrian and Early Ordovician time are principally sandstones and shales, in contrast to the limestones, dolomites, shales, and evaporites deposited in Middle and Late Ordovician, Silurian, and Devonian time (see table 1). The wide variety of sediments deposited in the Michigan basin is evidence of fluctuating sea levels and oscillating shorelines during each of the periods of the Paleozoic era. The seas of Mississippian and Pennsylvanian time were smaller than the seas of the earlier periods and no evidence indicates that they extended into the Northern Peninsula of Michigan.

Deposition of marine sediments in the Michigan basin ended with the final withdrawal of the sea at the close of the Paleozoic era. A period of erosion followed and lasted throughout the Mesozoic era and during most of the Cenozoic era. During this long interval of geologic time, great quantities of sedimentary rocks of Paleozoic age were removed by erosion. Thus, the rocks of Paleozoic age now cover a smaller area than they did in early Mesozoic time. Rocks of Late Silurian and of Devonian age, which crop out on the St. Ignace Peninsula and on the islands in the Mackinac Straits area, at one time presumably covered a large part of Chippewa County.

Lithology was a major factor in the differential erosion of sedimentary rocks of Paleozoic age. The softer, less competent shales and sandstones and the soluble evaporites were most easily eroded, and buried and submerged valleys mark the traces of pre-Pleistocene exposures of these formations. Cuestas and bedrock-surface highs mark exposures of the more resistant limestones, dolomites, and sandstones. These features, subsequently modified by Pleistocene glaciation, include the Niagara escarpment and the great valleys which now form the basins of the Great Lakes and associated bodies of water. In Chippewa County, tributaries to these major valleys are now filled with glacial drift (pl. 4).

During the Pleistocene epoch, the Great Lakes area was covered by at least four successive continental glaciers. As these ice sheets moved southward from ice-accumulation centers in Canada, they scoured and abraded the land surface, rounding the hills and deepening the valleys. The advancing glaciers transported vast quantities of rock materials of all sorts gouged and torn from the surface over which the ice moved. Melting of the ice resulted in deposition of the transported material (drift) over the Michigan basin. The glacial deposits and features of Chippewa County are predominantly of the last of the four recognized glacial stages, the Wisconsin stage.

In late Wisconsin time, Lake Algonquin, an early stage in the succession of the Upper Great Lakes, covered nearly all of Chippewa County. Figure 2 shows the boundaries of glacial Lake Algonquin. Some of the sediments transported by the glaciers during Wisconsin time were deposited in the waters of this lake. Lake Nipissing (pl. 3) was an important warm water intermediate stage, and Lakes Superior, Huron, and Michigan are the modern stage of this succession. The glacial deposits of Chippewa County were altered by the erosive forces of, and the deposition in, this succession of lakes.

Structure

The Precambrian surface upon which the sedimentary rocks of Chippewa County are deposited apparently is one of great relief. This is indicated by the log of well 47N 1W 23-1 located south of the city limits of Sault Ste. Marie. This well, drilled to a depth of 850 feet below sea level, did not reach Precambrian igneous and metamorphic rocks, although such rocks crop out at elevations of more than 600 feet above sea level a few miles north and east of Sault Ste. Marie, Ontario. The Precambrian surface presumably slopes southward toward the center of the Michigan basin. Precambrian rocks were not reached in a well drilled to a depth of more than 10,000 feet below sea level in the central part of the basin (Michigan Geological Society, 1954).

The sediments which form the consolidated rocks of the Michigan basin were deposited in nearly horizontal layers, but gradual subsidence and compaction of the beds, which was contamporaneous with deposition and was greatest in the center of the subsiding area, produced a bowl-shaped structure or basin (fig 4). The youngest beds are in the central part

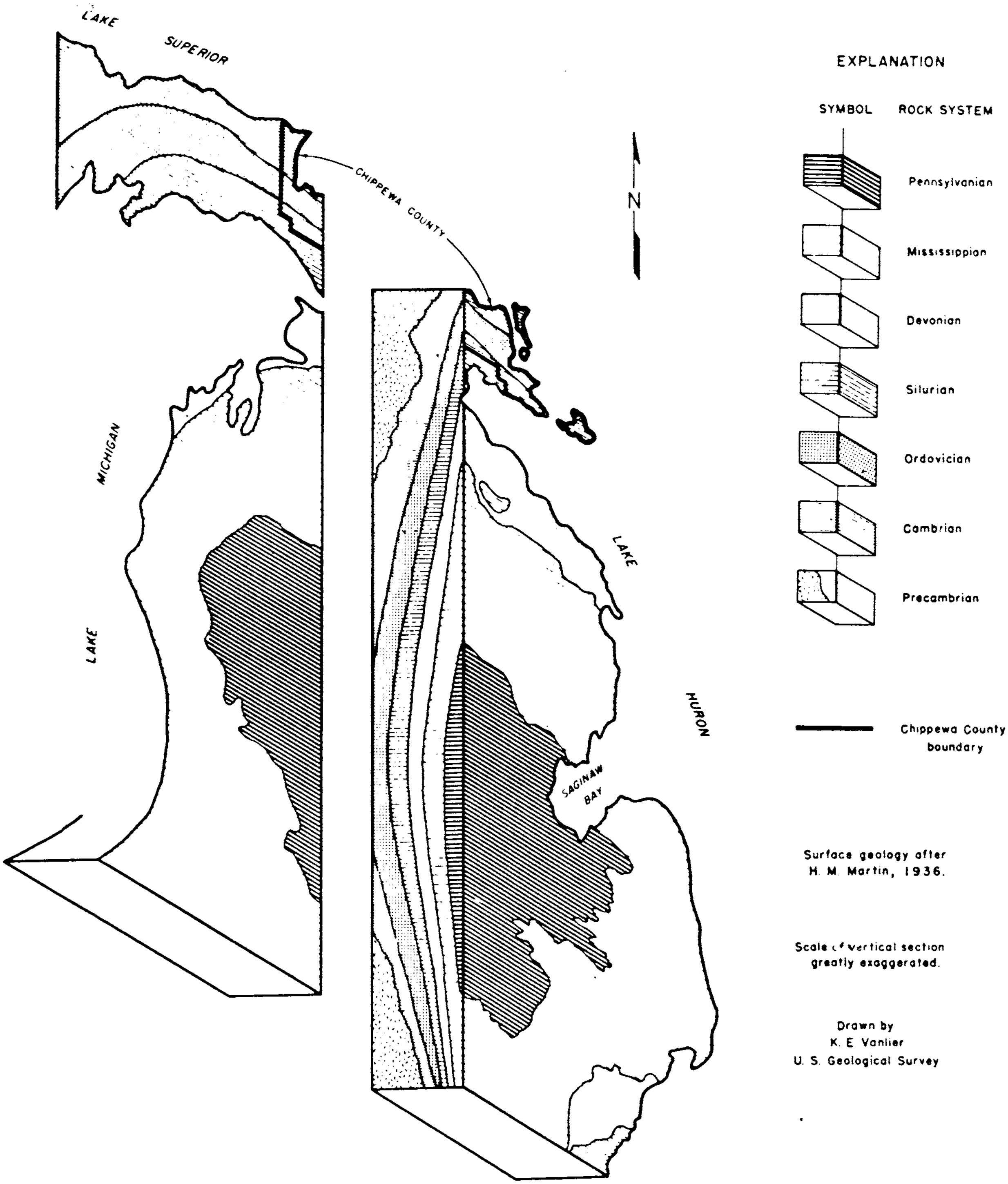
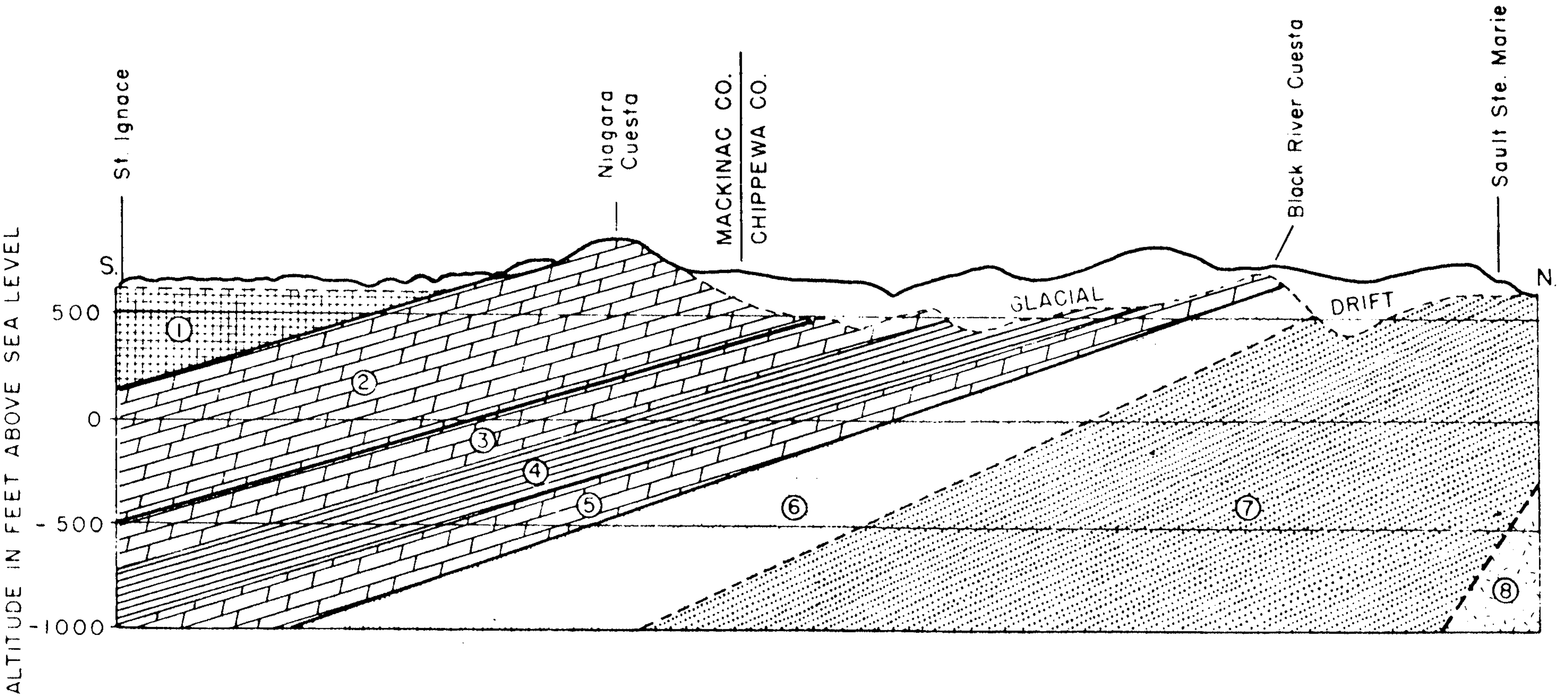


Figure 4.--Block diagram showing schematic geologic cross-section through the Michigan basin.

of this structure and older rocks crop out in roughly concentric bands. Chippewa County is on the northern edge of the basin, where the oldest sedimentary rocks are exposed (fig 5). The regional dip of these rocks in Chippewa County is about 40 feet to the mile southward toward the center of the basin. Most of the strata become thicker toward the center of the basin.



EXPLANATION

1 Upper Silurian and Devonian limestone, dolomite, shale, gypsum, and breccia.

2 Lower and Middle Silurian limestone and dolomite.

3 Upper Ordovician limestone and dolomite.

4 Upper Ordovician shale.

5 Middle Ordovician limestone and dolomite.

6 Upper Cambrian and Lower Ordovician sandstone and sandy dolomite.

7 Cambrian red sandstone (may include some Precambrian sandstone at base).

8 Precambrian igneous and metamorphic rocks.

Figure 5.--Generalized geologic section through the eastern end of the Northern Peninsula of Michigan.

GROUND WATER

Occurrence and Availability

A water-bearing formation that yields water in usable quantities is termed an aquifer. In areas where ground water is difficult to obtain, a formation yielding less than a gallon per minute to wells may be classed as a principal aquifer. In other areas where wells may yield several hundred gallons per minute, a rock from which wells obtain less than a few gallons per minute might not be classed as an aquifer.

The amount of water available to a well depends upon the regional and local lithologic and hydrologic characteristics of the aquifer, the climatic conditions in the area, and the hydrualic properties of the soils and subsurface units in the recharge areas.

On the basis of water occurrence, aquifers may be classified as water table or artesian. In a water-table aquifer, ground water is unconfined and the ground-water surface within the aquifer is termed the water table. In an artesian aquifer, ground water is confined under pressure between relatively impermeable strata (strata through which water does not move readily). Under natural conditions, the water in a well finished in an artesian aquifer and tightly cased through the overlying confining bed will rise above the bottom of the overlying confining bed. An artesian aquifer is full of water at all times, even while water is being removed from it. In time, however, enough water may be pumped to draw the water level below the bottom of the overlying confining bed, thus creating water-table conditions locally. The imaginary surface consisting of all points to which water would rise in wells that tap an artesian aquifer is called the piezometric surface.

In topographically low areas, the piezometric surface may be higher than the land surface, and wells tapping artesian aquifers in these areas will flow. Such areas in Chippewa County are shown on plate 6.

The aquifers underlying Chippewa County consist of several types of consolidated and unconsolidated rocks. In general, the unconsolidated-rock aquifers (those in the glacial drift and glacial lake deposits) are the most accessible and dependable sources of ground water in the county and have the greatest potential for future develo- ment. In areas where the mantle of unconsolidated sediments is thin or lacks permeable zones, the consolidated rock aquifers may be the only source of ground water.

Ground Water in Consolidated Rocks

Precambrian igneous and metamorphic rocks and consolidated sedimentary rocks of Paleozoic age underlie all of Chippewa County. These rocks crop out in many places throughout the Northern Peninsula and in Ontario. Descriptions and names of the formations, members, and other lithologic units in Chippewa County differ considerably among the various authors who have reported on the geology of the Northern Peninsula. Many of the units have been described only in specific localities and work done to date in correlating these units across the Northern Peninsula is incomplete. That facies changes are common is proved by the fact that descriptions of rock units in the out-crop areas differ somewhat from descriptions of the same units in records of deep borings.

The geologic age of most sedimentary rocks is determined from fossils. Intensive and detailed paleontological studies have not been made in Chippewa County, as fossils are scarce in the drill cuttings taken from deep borings. Thus, accurate delineations and regional correlations of the formations, members, and other units of the stratigraphic section in Chippewa County have not been attempted. In this report, therefore, the units used in describing these rocks represent rather broad and basic divisions of geologic time; no attempt is made to describe stratigraphic units smaller than the series, but rather to delineate major hydrologic units.

Several of the consolidated rock units are important aquifers. The sandstones are a source of ground water in Chippewa County and in many places throughout the eastern part of the Northern Peninsula. The limestones and dolomites are important aquifers throughout most of the area where, during preglacial time, permeable zones were developed in the exposed rocks by weathering and solution. Shale beds or units of shale interbedded with layers of limestone and dolomite are of low permeability and will yield little water to wells. They are significant in the hydrologic system, however, because most shales impede vertical movement of ground water and hence retard solution in underlying soluble rocks and act as confining beds in artesian systems.

Precambrian rocks.--Precambrian quartzite and other metamorphic and igneous rocks are exposed a few miles northeast of Sault Ste. Marie, Ontario, but are not at or near the surface in Chippewa County. Neither the configuration of the Precambrian surface nor the depth to that surface, except at one point on Neebish Island, is definitely known. Well 45N 2E 34-1, drilled on Neebish Island in 1900, is reported to have entered Precambrian quartzite at a depth of 506 feet below the land surface. However, no other wells or test borings in the county are known to have penetrated completely all the rocks of Paleozoic age, despite the fact that at least one well was drilled to a depth of nearly 1,600 feet. Because of their great depth and probably low permeability, water is not obtained from the Precambrian rocks in the county, and future development of these rocks as a major source of potable water is unlikely.

Red sandstone of Cambrian age.--A red, pink, and white arkosic sandstone, which includes some layers of red, brown, and gray shale, underlies all of Chippewa County. Thwaites (1943, p. 501) reported cross-bedding in this sandstone and stated that it is of nonmarine origin. He also surmised that the lower part of the sandstone is Precambrian. Well drillers commonly refer to this unit as the "red sandstone" and state that most of the sandstone is very hard and resistant to drilling, although locally it may be soft and may contain layers of shale. A hard, resistant ridge of this sandstone forms the falls of the St. Marys River at Sault Ste. Marie. The red sandstone is exposed also along the northern edge of Sugar Island, where it is fractured. The sandstone has a great range in thickness. South of Sault Ste. Marie, Mich., it is over 1,300 feet thick, but it pinches out abruptly a few miles to the north and east in Ontario.

The red sandstone is an important source of water in the Sault Ste. Marie-Sugar Island area, where it is exposed or is mantled by glacial drift. The configuration of the buried surface of the sandstone is not accurately known, because locally the materials at the base of the drift closely resemble the soft, weathered sandstone from which the drift has been largely derived. In this area it is difficult to determine accurately the contact between drift and bedrock. Wells are completed in the sandstone in locations where the drift is thin or of low permeability. Where the sandstone and permeable drift are in contact, they constitute a single aquifer. The sandstone appears to be most permeable in the upper part where it is fractured and weathered. Thus, nearly all the wells tapping the sandstone produce water from the upper part of the unit. The low permeability of the sandstone at depth is shown by well 47N 1W 23-1, which was drilled more than 1,400 feet into the sandstone and produced only 8 gpm, and by well 47N 2W 4-5, which was drilled 325 feet into the sandstone and also yielded only a few gallons per minute. Well 47N 1W 11-1, which is the most productive well in the red sandstone known in the county, is 998 feet deep. This well is reported to produce 250 gpm. Most of the water, however, is reported to be produced from the 150- to 200-foot zone. Several wells in the Sault Ste. Marie area produce saline water from the red sandstone (table 7).

Sandstone and sandy dolomite of Late Cambrian and Early Ordovician age.--Beds of white and gray fine- to coarse-grained sandstone, dolomitic sandstone, and sandy dolomite underlie all of Chippewa County except the area mapped as red sandstone of Cambrian age on plate 2. In Chippewa County these rocks crop out at Sault Point in sec. 30, T. 47 N., R. 4 W. (VerWiebe, 1928, p. 310) and at the lower falls of the Tahquamenon River (Rominger, 1873, p. 85; VerWiebe, 1928, p. 309). These rocks include the Munising formation of Late Cambrian age and the Hermansville limestone of Late Cambrian and Early Ordovician age (table 1). Their aggregate thickness is about 180 feet in well 45N 2E 34-1, on Neebish Island, and 300 feet in well 45N 1E 18-1, several miles west of Neebish Island. It is believed that these strata are thickest in the western part of the county.

The sandstone beds are permeable and constitute one of the principal aquifers of the Northern Peninsula. The dolomitic layers are less permeable and no wells in Chippewa County are known to have been completed in them. Most of the wells that produce water from the sandstones are in the northeastern part of the county, where the sandstones are mantled only by glacial drift. A few wells are completed in the sandstones where they are overlain by younger consolidated rocks. Assuming that depth and economic considerations make drilling feasible, properly constructed wells tapping these sandstones throughout most of Chippewa County may be expected to yield moderate to large amounts of fresh water; where topographic and geologic conditions are favorable, wells tapping these sandstones may flow. Several deep wells in the Pickford and Rudyard areas, which were drilled in search of oil, produced large flows of fresh water from these sandstones.

Limestone and dolomite of Middle Ordovician age.--Rocks of Middle Ordovician age in the Northern Peninsula are represented by a series of limestone and dolomite layers which lie unconformably on the sandstone and sandy dolomite of Early Ordovician age. Thin beds of sandstone and shale are interbedded with the limestone and dolomite. The limestone and dolomite are mostly hard and resistant to erosion, and to drilling. The Middle Ordovician rock sequence in Chippewa County includes the Trenton and Black River limestones, which are described in detail in the literature (Hussey, 1936; Coheė, 1945b).

In preglacial time, the limestones and dolomites were eroded to form a cuesta having a northward-facing escarpment and a gentle southward dip slope (fig 5). This Black River cuesta (Thwaites, 1946, p. 20) trends in a general east-west direction across the northern part of Chippewa County. Glacial deposits of Pleistocene age now mask the cuesta in all but a few places in the county. Rocks of the Trenton and Black River limestones are exposed along the crest of the structure at the rock cut at Neebish Island and along the bank of the Waiska River in sec. 29, T. 46 N., R. 2 W. (Rominger, 1873, p. 63-64; VerWiebe, 1928, p. 311; Hussey, 1952, p. 27, 46). The record of well 45N 1E 14-1 logs rocks of Middle Ordovician age in that vicinity at or near the land surface. At Dafter, these rocks were reported at a depth of 34 feet. The thickness of the Black River-Trenton rocks is reported to be about 210 feet in well 44N 2W 8-7.

Where limestone and dolomite of Middle Ordovician age were exposed in preglacial time (pl. 2) and are now mantled only by glacial drift, openings along fractures and bedding planes have been enlarged by solution. Wells that tap these openings will produce small to moderate supplies of water. As solution must have been greatest in the upper part of the exposed limestone and dolomite, permeability of the rocks probably decreases with depth. Drillers have reported that the solution openings locally have been filled with unconsolidated sediments. These sediments, if permeable, also will yield water to wells. Where overlain by shale of Late Ordovician age, movement of ground water through the limestone and dolomite is impeded, the solution process is retarded, and the rocks remain relatively impermeable. Two wells in the Rudyard area, however, were reported to have produced small flows of sulfurous water from the top of the limestone and dolomite of Middle Ordovician age where they are overlain by shale.

Sandstones and sandy layers associated with the limestones and dolomites in some areas yield small to moderate supplies of water. Well 44N 1E 14-1 produces a flow of water from 30 feet of sandstone interbedded with limestone and dolomite of Middle Ordovician age. This sandstone, which produced saline water, was not found in other deep borings in the county.

Shale of Late Ordovician age.--Shale of Late Ordovician age is not exposed in Chippewa County, but is described in records of deep wells throughout the Northern Peninsula as a sequence of black bituminous and gray dolomitic shales. The shale is reported to be about 250 feet thick in the county. About 85 feet of shaly dolomite within this sequence was drilled in well 41N 7E 17-1 on Drummond Island. The shale and associated dolomite have very low permeabilities and do not yield water to wells in Chippewa County.

Limestone and dolomite of Late Ordovician age.--Limestone and dolomite of Late Ordovician age totaling about 240 feet in thickness overlie the shale of Late Ordovician age. These rocks crop out in the northern part of Drummond Island where, according to VerWiebe (1928), they are dark-gray shaly limestone. According to the records of deep wells in and near Chippewa County, only a small part of the limestone and dolomite drilled contained appreciable quantities of shale. As overlying rocks of Early and Middle Silurian age are also limestone and dolomite, the contact between the rocks of Ordovician and Silurian age cannot be readily determined in deep borings where fossils are absent. Thin beds of red and green gypsiferous shale, which are nearly everywhere near the base of the Silurian system, indicate the proximity of limestone and dolomite of Ordovician age.

In some areas, the limestone and dolomite of Late Ordovician age are permeable and will yield small to moderate amounts of water. Most of these areas are where the rocks were exposed in preglacial time (pl. 2). In these areas, younger rocks of Paleozoic age have been removed by erosion before Pleistocene time and solution openings have developed along fractures and bedding planes in the exposed limestone and dolomite. The permeability of the limestone and dolomite of Late Ordovician age is primarily the result of such solution. The record of well 44N 2W 8-7 shows that most of the 85 feet of Upper Ordovician dolomite is permeable. A number of flowing wells have been completed in these rocks in areas of low elevation. Well 44N 2W 18-1, near Rudyard, flows at a rate of about 20 gallons per minute.

Where the limestone and dolomite of Late Ordovician age are overlain by shale of Silurian age, the movement of water has been impeded and solution retarded. Upper Ordovician rocks in such areas are of low permeability and will yield little water to wells.

<u>Limestone and dolomite of Early and Middle Silurian age</u>.--Rocks of Early and Middle Silurian age are the youngest of the consolidated rocks in Chippewa County. They have an aggregate thickness of more than 500 feet and are primarily hard, resistant limestone and dolomite, but they include some cherty beds and some gypsiferous, calcareous, and dolomitic shales at the base.

Rocks of Early Silurian age are not known to have been tapped for water by any wells in Chippewa County, and hence little is known of their water-bearing characteristics. Where present in the county, they are nearly everywhere overlain by limestones and dolomites of Middle Silurian age which are important sources of water, and most wells are completed before the Lower Silurian strata are reached. The only known exposure of rocks of Early Silurian age in Chippewa County is on the west side of Drummond Island (Cohee, 1948).

Rocks of Middle Silurian age form the Niagara cuesta, which trends in an east-west direction along the southern part of Chippewa County. Numerous exposures of the rock, and several quarries are located along the cuesta. Rocks forming the cuesta are the source of many springs which issue from the north-facing escarpment and also from the dip slope of the cuesta. The water feeding the springs moves in fractures and in crevices along bedding planes, which have been enlarged by solution. Such solution openings are the principal source of water in wells drilled into the limestone of Middle Silurian age in Chippewa County. The amount of solution apparently differs greatly from stratum to stratum, and great ranges in permeability within individual strata are probable. At certain horizons, especially where the rock is composed largely of relatively pure limestone, which dissolves more readily than dolomite, the rock may be very productive over a large area. Solution caves west of Trout Lake in the Fiborn area of Mackinac County have been formed in limestone of Middle Silurian age. In areas where the Middle Silurian limestone and dolomite are exposed at the surface, the strata are fractured and weathered and are very permeable. These areas provide an avenue for direct recharge of ground water.

Ground Water in Unconsolidated Deposits

Most of the unconsolidated rock in Chippewa County was deposited during the final or Wisconsin stage of the so-called Ice Age (Pleistocene epoch). These deposits, which consist of a heterogeneous mixture of rock debris known as glacial drift, are the most important aquifers in the county and offer the greatest possibility for future development. The general term "glacial drift" embraces all types of rock material deposited by or from glacial ice or its melt waters. Although some of this drift was carried great distances by the ice, much of the material was carried only a short distance. Flint (1947, p. 114) states that "the average distance traveled by a rock fragment from the time it is picked up by the glacier until it is deposited is only a few miles." Thus, the glacial drift may be closely related to the underlying bedrock, especially at the base, and in many wells the contact between the drift and the bedrock cannot be accurately determined.

The glacial deposits of the county consist predominantly of outwash deposited by melt-water streams; till deposited by ice in the waters of glacial Lake Algonquin; and lacustrine sand, silt, and clay deposited also in glacial Lake Algonquin. Minor amounts of windblown sand and till deposited on the land surface also are included within the drift deposits.

In many areas of Michigan, surficial deposits of outwash, till, and lacustrine sediments are readily differentiated by lithologic and topographic expression. Such is not the case in Chippewa County because in some areas both till and outwash deposits were derived from a common source of sandstone composed of well-sorted grains and are physically similar. In addition, the surface features have been greatly modified by the erosive forces of and deposition of sediments in glacial Lake Algonquin and Lake Nipissing. Hence, the map of the surface geology (pl. 3) should be used only as a general aid in locating ground-water supplies. Test drilling is essential to appraise adequately the ground-water resources of the drift aquifers.

The drift has a great range in thickness over the county. Where valleys or channels were cut into the underlying bedrock and subsequently filled with glacial sediments, the drift is as much as 400 feet thick. In areas adjacent to the Niagara escarpment and other bedrock highs, the drift is thin and discontinuous (pl. 5). Well records and seismic data indicate that at least three and possibly four major pre-Pleistocene valleys or channels were cut into bedrock in the eastern part of the county (pl. 4 and table 5).

The drift-filled buried preglacial valleys are some of the best sources of ground water, they coincide roughly with valleys of the present major drainage systems. One bedrock valley extends from Whitefish Bay at Brimley along the course of the Waiska and Pine Rivers to Rudyard and on to Lake Huron. Leverett (1929, p. 15) states that this bedrock channel was the preglacial connection between Lake Superior and Lake Huron. Another bedrock valley leading from Brimley to Neebish Island is in alignment with the present course of the Charlotte River. A third bedrock valley is along the course of the Munuscong River north of the Niagara escarpment. A study of the altitude and locations of the areas of pre-Pleistocene exposures of shale of Late Ordovician age indicates the existence of a fourth valley trending generally along the present course of the Little Munuscong River. However, proof of this valley and its position is lacking at present. In the eastern part of the county, the greatest drift thicknesses and the lowest bedrock elevations are reported in records of wells drilled close to the channels of present-day streams. In the western part of the county, insufficient bedrock data are available to map the trend and configuration of preglacial valleys. However, well records indicate that much of the drift in that area is quite thick.

Moraines.--The moraines of Chippewa County (pl. 3) are ridges of glacial till deposited for the most part in the waters of glacial Lake Algonquin along the relatively static front of a glacier which was melting back at approximately the rate of forward movement of the ice sheet. Only a small part of one of the moraines in Chippewa County is known to have been deposited on land. This deposit was mapped by Leverett (1929, pl. 1) in parts of Twps 46 and 47 N., R. 5 W.

The glacial till of which the moraines are composed is a mixture of rock debris transported by ice and deposited by melting of the ice without subsequent transport by wind or water. Commonly the moraines include, and are associated with, deposits of stratified outwash. The nature of the till, however, varies with the sources from which it is derived. Most of the moraines of Chippewa County situated north of the buried Black River escarpment are composed of sandy and gravelly till derived primarily from the sandstone formations of Cambrian and Early Ordovician age described above and to a lesser extent from older igneous and metamorphic rocks of the Canadian Shield. Most of the moraines in Chippewa County composed of clayey till or boulder clay are south of the Black River Escarpment, where the till was derived from shale, limestone, and dolomite of Paleozoic age. Accurate delineation of the various types of till present in the county is beyond the scope of this reconnaissance report.

Much of the land-laid till is unsorted and unstratified, but most of the till in Chippewa County was deposited in glacial

Lake Algonquin, and was therefore sorted and stratified to some degree by the lake waters. The degree of sorting of the till ranges greatly. In some areas the sorting is rudimentary. Elsewhere the till is difficult to distinguish from well-sorted outwash or dune deposits, inasmuch as the major source of such till was sandstone composed of well-sorted particles.

The permeability of the morainal deposits varies generally with the degree of sorting, the size of the till particles, and the amount of interbedded outwash material. Large supplies of water may be obtained from moraines which include significant deposits of permeable outwash. Moraines in the western half of the county and in the Kinross area, which are composed largely of sand and gravel, yield moderate supplies of water. In the eastern part of the county, much of the moraines are clayey till and are relatively poor sources of water supply.

Till plains or ground moraines.--The till plains or ground moraine of Chippewa County (pl. 3) are plains of glacial till similar in physical character to the morainic deposits. Most of these deposits mantle parts of the Niagara escarpment in the southeastern part of the county, and Drummond Island. In these areas the deposits are thin, and in many places are above the zone of saturation, and hence are not important sources of ground water. Locally within those areas the till may yield small amounts of water.

Throughout much of the county, thin deposits of till which have been covered by wind and lake sediments may yield small quantities of water.

Outwash plains.--Outwash plains are plains of stratified sand and gravel deposited by glacial melt-water streams. In Chippewa

County, much of the outwash was deposited in the glacial lakes and is deltaic in character. The deposits are closely related to and in places are incorporated within the moraines. The outwash deposits are the most permeable sediments of the glacial drift and yield moderate to large supplies of ground water. The log of well 45N 1W 29-1 (table 4) shows permeable outwash deposits to a depth of 145 feet. Well 46N 4W 28-1 penetrated permeable outwash consisting almost entirely of very fine to coarse sand. Pumping at a rate of 115 gallons per minute in this well lowered the water level 27 feet after 8 hours of pumping. Several areas of outwash and areas where outwash deposits are not differentiated from morainal deposits are shown on plate 4. Subsurface outwash deposits in other areas can be located by test drilling or perhaps by geophysical methods.

Lake plains.--Stratified layers of clay, silt, and fine sand deposited by the waters of glacial Lake Algonquin (fig 2) lie at the surface over much of Chippewa County. These sediments are reported to be more than 300 feet thick in some areas. A typical section of lake deposits consists of a thick layer of pebble-free red or gray varved clay underlain by layers of finely laminated silt and fine sand. The silt and fine sand deposits are called "quicksand" by most of the drillers in the area. A typical section is illustrated by the log of well 43N 1E 15-1 (table 4). Locally, beds of coarser sand or gravel outwash are interbedded within the lake-deposited sediments.

Most of the wells drilled in the areas underlain by lake deposits (pl. 3) produce water from outwash or till, which underlies the lake deposits, or from sand and gravel layers within the lake deposits. The Michigan State Highway Department bored test hole

44N 2W 24-1 (table 4) through 56 feet of soft lake clay before reaching water-bearing outwash deposits. The water in this aquifer was under sufficient artesian pressure to flow at the surface. Well 46N 1E 8-4 (table 2) is one of several large-diameter dug wells which produce water from the "quicksand" layers. However, few drilled wells are completed in the lake silt and fine sand, although small yields might be obtained from properly constructed drilled wells.

The lake-clay deposits are of low permeability and yield little water to wells. However, they do act as confining layers in artesian systems. Most of the flowing artesian wells in the county are in topographically low areas (pl. 6) where the drift and shallow bedrock aquifers are confined by lake clays.

Dunes and beaches.--Dunes and beach deposits associated with glacial Lake Algonquin and post-Algonquin lakes are found throughout the county. These sediments consist of permeable windblown (eolian) sand and beach sand and gravel. Most of the dune areas are associated with the beach deposits. Plate 3 shows one large dune area in T. 47 N., R. 3 W., at the northern edge of the county along Whitefish Bay. Other dune and beach areas have not been delineated on the map. Locally, the deposits may yield small to moderate supplies of water to shallow wells. The dune and beach deposits have high infiltration capacities and provide an important avenue of recharge to the underlying ground-water reservoirs.

Ground-Water Phase of the Hydrologic Cycle

Source and Recharge Areas

The initial source of all fresh ground water in the aquifers of Chippewa County is precipitation. The average annual precipitation over the county exceeds 30 inches. If all the moisture that fell upon the county entered into uniformly distributed permeable aquifers, a bountiful supply, which would more than satisfy any foreseeable needs, would be insured. However, most of this water does not enter the ground-water reservoirs, but is lost by evaporation, by transpiration, and by surface runoff to the Great Lakes drainage system.

The amount of precipitation that does enter the ground-water reservoirs is influenced by a number of factors including the duration, intensity, and type of precipitation, the density and types of vegetation, the topography, and the porosity and permeability of the soil, subsoil, and underlying rock formations. Porosity is the percentage of volume of open or pore space to the total volume of a rock and is indicative of the capacity of a rock or soil to store water. The capacity of a rock to transmit water is a function of its permeability. The coefficient of permeability is a measure of the rate at which a fluid of specified density and viscosity flows through a unit cross-sectional area under a unit hydrualic gradient. Ferris and others (1954) discussed in greater detail the hydrologic cycle as applied to drift and bedrock aquifers in Oakland County, Mich.

In the lake-plain and till-plain areas of Chippewa County the rather impermeable soils promote runoff and hinder recharge to underlying aquifers. Surface drainage courses have developed in these areas. The more permeable moraines of the uplands, the outwash-plain deposits, and the beach and dune sands, however, are able to transmit recharge to the aquifers more rapidly. In areas underlain by these deposits, surface drainage courses are poorly developed or nonexistent.

Movement

The movement of water underground is similar to movement in surface streams, that is, the water moves by gravity from high levels to low levels. The movement of water underground is much slower than the movement of water at the surface, because of friction generated by water in percolating through crevices and interstices in the earth's crust. Rates of ground-water movement range from a few feet per year to several feet per day. Water may travel great distances underground from regions where recharge is received at the surface to areas down-gradient, where it may once more reach the surface and join the flow of streams, appear as a seep or spring, enter a lake, or escape directly to the atmosphere by evaporation or transpiration.

The general direction of ground-water movement in Chippewa County can be determined from the water-level contours shown on plate 6 (see table 6). Movement of ground water is always in the direction of the hydrualic gradient at right angles to the contours. Unlike surface flow, the gradient may or may not conform to the topographic gradient in any particular area. Where it is undisturbed by man-made diversions the water level of an underground reservoir conforms approximately to the general configuration of the overlying land surface. Water levels in individual wells are given in table 6. It should be clearly understood that the contours shown on plate 6 are generalized and that the actual pattern of flow in any given aquifer is complex. In addition, the contours shown on plate 6, interpolated from all available hydrologic data, represent a combination of the configurations of the water tables and piezometric surfaces in many drift and bedrock aquifers.

Where more than one aquifer underlies an area, water will percolate or "leak" from the aquifer having the higher head to the one having lower head. The map does not show the water tables and piezometric surfaces of all the aquifers in the county. The piezometric surfaces of the deeper consolidated rock aquifers may differ from the surface shown on plate 6.

Discharge

Water is discharged from the ground-water reservoirs by evaporation and transpiration (evapotranspiration) and by wells, springs, and drains. The quantity of water lost by evapotranspiration in Chippewa County is not known, but the amount of evaporation from water and wetland surfaces probably is comparable to similar loss in Schoolcraft County (see section on Climate). The amount lost by transpiration on a countywide basis cannot be measured, but is presumed to represent a large percentage of the ground water discharged, inasmuch as most of the county has a shallow water table and is covered by dense forest.

A considerable amount of water is also discharged from the ground-water reservoir by springs. Most of the springs in the county are along the edge of the moraine and outwash highlands and along the Niagara escarpment. The streams issuing from some springs and seeps have eroded into the lake plains.

Pendills Creek, which is supplied from a number of springs in secs. 24, 25, 32, 33, and 34 of T. 47 N., R. 4 W., had a total discharge of about 17,000 gallons per minute on July 17, 1956. Big Spring in the southeast corner of sec. 22, T. 44 N., R. 4 W., flowed at a rate of about 1,600 gallons per minute on July 3, 1956.

The greatest amount of discharge by wells is from aquifers tapped by numerous flowing wells, and it is believed that the perennial flow from these wells greatly exceeds the discharge from pumped wells. The total amount of water discharged by all wells is undoubtedly small compared with the total natural ground-water discharge.

Fluctuations of the Water Table

Seasonal Fluctuations

Ground-water levels in the county fluctuate with seasonal changes in the rate of recharge to and discharge from the ground-water reservoirs. During the spring thaw, water levels in wells normally rise in response to the infiltration of rain and melting snow. Summer temperatures cause an increase in evapotranspiration, and a reduction in the opportunity for recharge resulting in declines of water levels. Thus, rainfall in the county during the growing season normally has little effect on the rate of decline, as vegetation utilizes most of the available moisture. In the fall, evapotranspiration losses are reduced and precipitation, after restoring depleted soil moisture, may cause rises in water levels. However, the decline in stage common during the summer may continue if precipitation is deficient or if an early general freeze impedes normal infiltration. Recharge to the ground-water reservoir in the winter is negligible because precipitation is predominantly in the form of snow.

Well 46N 4W 24-1 is the only well in the county in which water-level measurements have been made periodically. This well is relatively shallow and is completed in a glacial-drift aquifer which is under water-table conditions. The hydrograph of this well (fig 6) illustrates the relationship of temperature and precipitation to the water level. Water

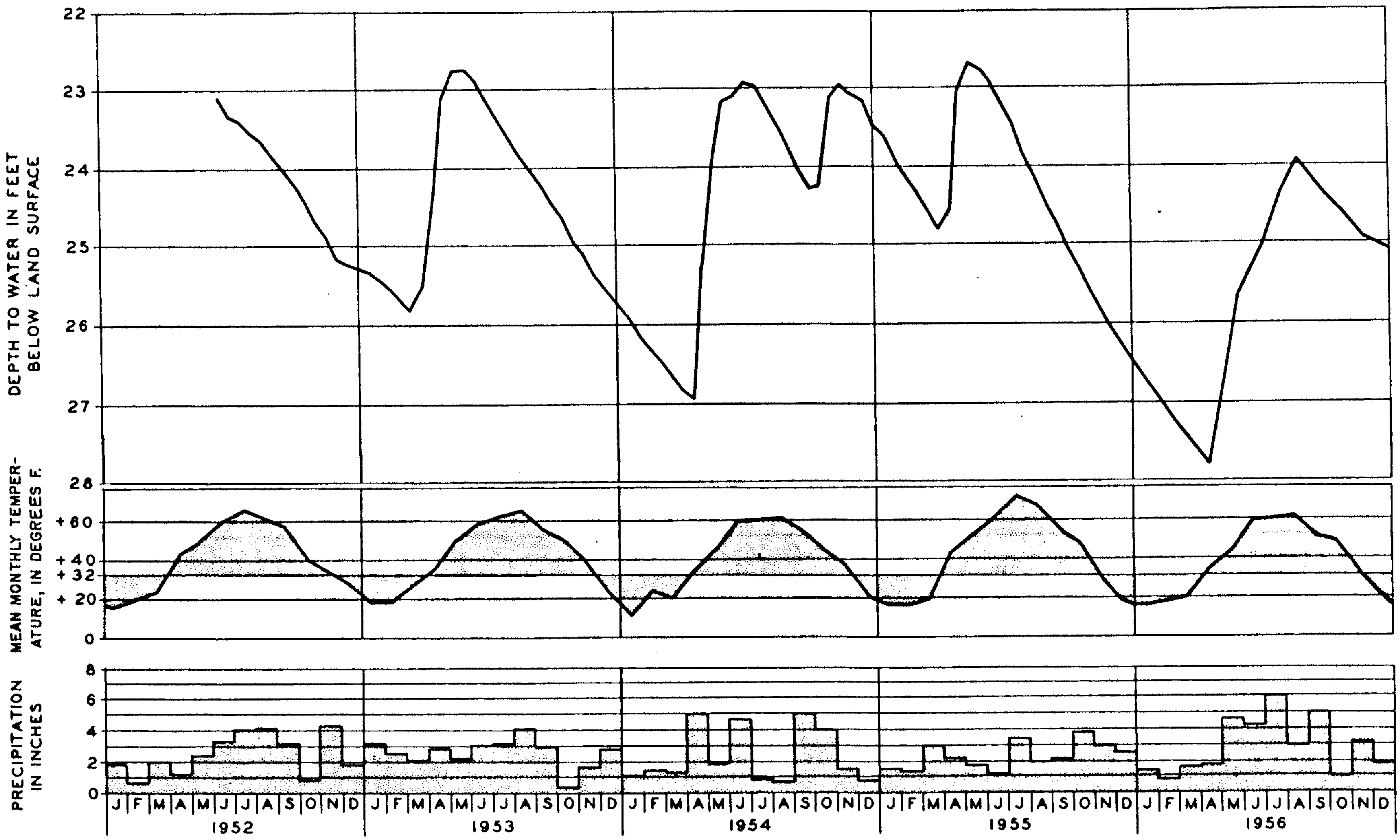


Figure 6.--Hydrograph of well 46N 4W 24-1 near Raco compared with graphs of temperature and precipitation recorded at Sault Ste. Marie, 1952-56.

levels rose during each of the spring seasons for the period of record and declined each summer, fall, and winter, with one exception. A sharp rise in water level during the fall of 1954 is shown on the hydrograph. The rise was caused by an above-average rainfall in September and October. Artesian pressures or water levels in the deeper aquifers may not respond as quickly or to the same extent as levels of the shallow aquifers, for accessibility to sources of recharge and avenues of discharge are not direct.

Flucutations Due to Discharge from Wells

Generally, ground water is a renewable natural resource because it is intermittently or continually being replaced directly or indirectly by precipitation. If an aquifer is to be developed by means of wells so that a long-term yield can be obtained without dewatering the aquifer, then equilibrium must exist between the rate of recharge to the aquifer and the rate of discharge from the aquifer (Theis, 1940). In any aquifer in its natural state (before it is tapped by wells) an approximate dynamic equilibrium exists between recharge and discharge. When water is withdrawn from an aquifer by a well, a change in the rate of total discharge from the aquifer results. The increase in discharge causes a depressed cone-shaped depression in the water table or piezometric surface around the discharging well. With continued discharge, the cone of depression expands until the resultant lowering of water levels causes a decrease in discharge from the aquifer or an increase in recharge to the aquifer, which restores the aquifer to a state of equilibrium.

Wells within the cone of depression may be affected by the lowering of water levels or artesian pressures. Thus, a well tapping an aquifer is affected by the discharge of other wells that tap the same aquifer. Where several or many wells discharge, a composite cone of depression is formed, which may extend over a large area. The lowering of water levels over a large area may cause a considerable increase in the rate of recharge to or a considerable decrease in the rate of natural discharge from an aquifer. A lowering of the water level, therefore, is necessary in the development of a ground-water reservoir or aquifer. Waste of water by unrestricted flow of wells or by underground leakage from poorly constructed wells or deteriorated well casings results in an unnecessary lowering of the piezometric surface, which may cause some wells to stop flowing, decrease yields, and increase the cost of producing water. The same effects result as the aquifer is further developed by installation of additional flowing wells. Many of the flowing wells in Chippewa County are reported to show the effects of decreased artesian pressure.

Utilization of Ground Water

Much of Chippewa County is bounded by the waters of the Great Lakes, which provide a potentially unlimited source of fresh water for conveniently located users. Sault Ste. Marie, the largest municipality in the county, obtains its water supply from the St. Marys River. Other towns and villages and nearly all of the farm residences, resorts, motels, and other users tap ground-water sources for supplies.

Brimley is the only municipality that has a public ground-water supply; other villages and towns are supplied by privately owned wells. It is estimated that about 6,000 people residing in the county utilize the ground-water resources. The water is used almost entirely for domestic purposes or for watering stock. The amount used represents only a small fraction of the total resource available.

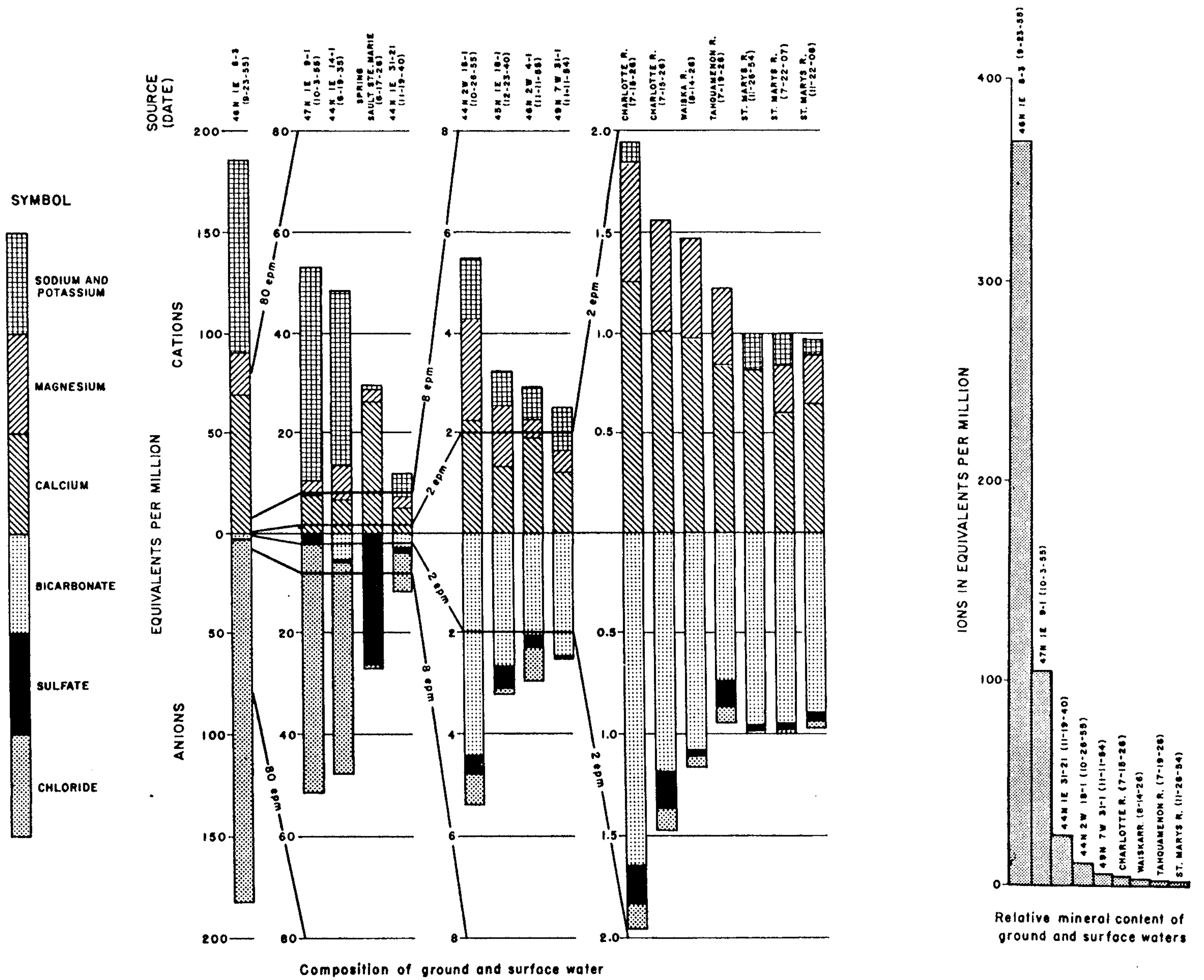
QUALITY OF WATER

The chemical composition of the waters in Chippewa County are graphically presented in figure 7, which illustrates the great range in composition of ground and surface waters from several sources. Although a comprehensive program of chemical analysis and geochemical interpretation of the waters of the county was not carried out during this reconnaissance, sufficient data were gathered to reveal the chemical nature of some of the different waters (table 7).

Fresh Ground Water

Much of the fresh water in the aquifers of Chippewa County is of the calcium magnesium bicarbonate type. Water from the drift or sandstone aquifers is relatively high in calcium bicarbonate compared to water from dolomite or dolomitic limestone or dolomitic sandstone aquifers which is relatively high in magnesium bicarbonate. Thus, a high magnesium-to-calcium ratio indicates that the source aquifer is dolomitic or that some of the water has migrated through dolomitic rocks.

The hardness of water samples taken from the glacial drift in the county ranged from 50 to 150 parts per million (ppm). This water is soft compared with water produced from drift aquifers in other areas of the State. The hardness of samples of fresh water from bedrock aquifers ranged from 170 to 365 ppm.



Composition of ground and surface water

FIGURE 7. Chemical composition of water in Chippewa County.

Wells tapping the glacial drift yield water low in chloride and sulfate content, although several drift wells were reported to have yielded "sulfur water" (probably water containing hydrogen sulfide). "Sulfur water" flowed from the limestone of Middle Ordovician age tapped by well 44N 2W 8-7. Oil shows are reported above and below the depth from which the "sulfur water" flowed. Well 44N 2W 7-3 drilled into the same stratigraphic unit also yielded water having an odor of hydrogen sulfide. A possible source of the sulfur in the water is the pyritiferous or other sulfide mineral zones in the limestone and dolomite of Middle Ordovician age.

The iron content of the water samples from the glacial drift ranged from near 0 to 12 ppm. Very high concentrations of iron, which greatly exceed the permissible maximum suggested for drinking water by the U. S. Public Health Service (Michigan Department of Health, 1948), were found in water samples from T. 45 N., Rs. 1 and 2E. (see table 7). A concentration of 16 ppm of iron in the water taken from well 45N 1E 18-1, which was finished in the red sandstone of Cambrian age, indicates that this rock may be the source of the iron in water found in the overlying glacial-drift aquifers.

Highly Mineralized Ground Water

The aquifers of Chippewa County also yield mineralized water in places. As used herein, and as applied to Chippewa County, mineralized water is defined as water containing more than 1,000 ppm of dissolved minerals. Although the origin of the mineralized water is not definitely known, connate water entrapped at the time of deposition of sediments in the Michigan basin is the probable source. The large variation in mineral concentration in water from the various sources sampled (table 7) is the result of mixing of this connate water with fresh ground water. Wells 46N 1E 8-3, 47N 1E 9-1, 47N 1E 10-1 and 10-2, and 47N 1E 21-2 all produce water containing high concentrations of sodium, calcium, magnesium, and chloride. These wells are aligned along a general north-south-trending axis. The alignment is in conformity with the strike of some of the major faults of the Precambrian shield described by Wilson (1948) and with the faulting at the eastern end of the Lake Superior geosyncline as postulated by Thwaites (1935). A fault zone may provide an avenue of increased permeability along which connate waters within the Michigan basin can migrate. This does not necessarily mean that mineralized waters move only along faults, as wells 44N 1E 14-1, 44N 1E 31-21, and 45N 2E 3-1, which are not in alignment with the wells listed above, produce water of moderately high mineral content.

Extensive pumping from deep wells in the area might reveal the mineralized water in the deeper aquifers throughout the county, as water migrates toward heavily pumped areas within an aquifer. A similar condition could develop if excessive discharges from unrestricted flowing wells caused an extensive lowering of the piezometric surface. A deep uncased well or unplugged test hole may provide an avenue along which mineralized water may flow to the surface or into overlying fresh-water aquifers.

An analysis of a sample of water taken from a spring near Sault Ste. Marie (fig 7) revealed unusually high concentrations of calcium and sulfate. At the present time, no other springs or wells in the county are known to yield water of similar chemical quality. The calcium and sulfate concentrations suggest percolation of this water through gypsum-bearing strata along the path of migration, but no such deposits are known in the vicinity of Sault Ste. Marie, although gypsiferous strata are known to be in the southern part of Chippewa County.

Surface Water

Analyses of surface waters in and bounding Chippewa County and of one spring at Sault Ste. Marie are listed in table 7. Although several of the analyses are somewhat in error, as indicated by the differences in cation-anion totals shown on figure 7, they reveal the mineral constituents and the magnitude of mineralization. Most of the surface waters are of the calcium magnesium bicarbonate type. The analyses show that the mineral content of water in glacial drift is approximately three times greater than the content of the surface-water samples analyzed. The effect of effluent discharge of ground water to the Charlotte, Waiska, and Tahquamenon Rivers is illustrated by the greater mineral content of these waters compared with the mineral content of the St. Marys River, which is the outlet for Lake Superior.

SUMMARY AND CONCLUSIONS

Small to moderate supplies of ground water suitable for most uses are obtained from wells throughout most of Chippewa County. Locally, properly constructed wells may yield as much as several hundred gallons of water per minute each. In extensive areas of the county, the water in many of the aquifers is under sufficient artesian pressure to cause wells to flow.

The glacial-drift aquifers, which are the most accessible source of ground water and which are tapped by most of the wells in the county, are believed to have the greatest potential for future development. Where drift aquifers are not present or will not yield sufficient water, various bedrock aquifers will yield adequate supplies. However, locally within the Sault Ste. Marie - Sugar Island area, obtaining a potable ground-water supply has been difficult. In other areas in the county where wells have yielded highly mineralized water, it is believed that properly constructed shallow wells will produce potable water.

Ground water sufficient for present needs and for considerable additional development is insured by the humid climate and by the extensive areas favorable for recharge. In some localities, waste of water from unrestricted flowing wells is causing declines in artesian pressure.

Most of the wells in the county are drilled to depths of less than 200 feet. Some wells were drilled several hundred feet before an adequate supply was obtained. However, application of modern well-construction and development techniques probably would increase the percentage of relatively shallow wells that could produce adequate supplies of water.

The chemical quality of ground water from the several major aquifers in Chippewa County differs considerably, and differences in quality exist also within a single aquifer. Locally, fresh water is hard and contains excessive concentrations of iron. Mineralized water unsuitable for most uses is produced from a few wells, and further data concerning the origin, source, and distribution of the mineral water in the aquifers of the county are needed. However, most of the water, which is of the calcium magnesium bicarbonate type, is of good quality and may be used for many purposes without treatment.

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Table 2.--Records of wells and test holes in Chippewa County, Mich.

Aquifer: Css - sandstone of Cambrian age; Odol - dolomite of Ordovician age; Ols - limestone of Ordovician age; Oss - sandstone of Ordovician age; Sls - limestone of Silurian age; Qgd - glacial drift of Quaternary (Pleistocene) age.

Use: D - domestic; I - industrial; O - observation well; P - public supply; S - stock.

Altitude: Estimated in feet above mean sea level from U. S. Geological Survey and U. S. Corps of Engineers topographic quadrangle sheets; U. S. Lake Survey charts; altimeter readings; highway and railroad profiles; and other data.

Former USGS No.: Chippewa County prefix designation (Cp) is omitted. Political township designations are as follows: Bm - Bay Mills; Br - Bruce; Cp - Chippewa; De - Detour; Df - Dafter; Dr - Drummond; Hb - Hulbert; Kr - Kinross; Pf - Pickford; Rb - Raber; Ry - Rudyard; Sg - Sugar Island; So - Soo; Sp - Superior; Tk - Trout Lake; Wf - White Fish.

Remarks: MDC log - Complete log of well available from Michigan Department of Conservation, Geological Survey Division. Refer to permit number if listed.

Well designation T.R.	sec.No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude	Former USGS No.	Remarks
51N 5W	32-1	NE	SW	U. S. Coast Guard	--	--	22	--	Qgd	P	608	Wf 10	Water reported poor
50N 5W	5-1	NW	NW	Whitefish School	--	1938	18	1¼	Qgd	P	610	Wf 5	
	6-1	SE	NE	Brown Fisheries	Thos. Brown	--	15	1½	Qgd	P	610	Wf 15	Water reported good
	6-2	SE	NE	do.	--	--	102	4	Qgd	P	610	--	Well destroyed
49N 7W	28-1	--	--	--	--	--	16	--	Qgd	-	705	Wf 43	Flowed
	31-1	NE	SE	Mich. Dept. of Conserv.	F. A. Sherman	1954	192	4	Css	P	745	--	
	31-2	NE	SE	do.	Ross Payton	1947	103	2	Qgd	P	745	Wf 8	
	32-3	--	NE	do.	do.	1948	61	2	Qgd	P	--	Wf 7	
	32-4	NE	NE	do.	F. A. Sherman	1954	100	4	Qgd	P	629±	--	
	32-5	NE	NE	do.	J. H. Meehan	1949	48	2	Qgd	P	630	Wf 9	
	32-6	NW	NE	do.	F. A. Sherman	1954	100	4	Qgd	P	629	--	
49N 6W	3-1	NE	NE	A. H. Ervin	--	--	120	2	--	-	--	Wf 35	
	3-2	--	--		--	1902	250	--	Qgd	-	605	Wf 44	
	11-1	NW	NW	Harry Gamber	Harry Gamber	--	17	--	Qgd	P	608	Wf 38	Water reported soft
	22-1	SW	SE	Kenneth Kitto	Kenneth Kitto	1949	21.5	2	Qgd	P	625	Wf 26	Bedrock at 60 ft.
	22-2	NW	SE	M. Jenke	M. Jenke	--	28	1½	Qgd	P	625		
	22-3	SW	SE	Paradise School	--	--	22	2	Qgd	-	628	Wf 6	
	22-4	SW	SE	Kenneth Kitto	--	--	10	1¼	--	-	625	Wf 27	
	27-1	SW	SE	Whitefish Twp. School	Leonard Ellis	1949	36	2	Qgd	P	645	Wf 3	
	27-2	SW	SE	do.	do.	1949	101	2	Qgd	P	645	Wf 4	
	34-1		NE	Clark's Cabins	--	--	60	1½	--	-	610	Wf 2	
	34-2	SW	NE	M. DePetro	Robertson	1951	75	--	Qgd	P	610	--	Flows; Water reported good
48N 6W	14-1	--	--	Emerson Sawmill	--	1890	117	1¼	Qgd	I	610	Wf 48	Flowed
	14-2	--	--	do.	--	--	--	--	--	I	602	Wf 50	Flowed Well in lake
	14-3	NW	SW	Emerson Post Office	--	--	--	--	--	P	605	Wf 46	Flowed
	15-1	SW	NE	Mich. State Campground	Jack Meehan	1948	160	4	Qgd	P	605	Wf 40	Flows
	32-1	NE	SW	Superior Rod and Gun Club	Leonard Ellis	--	40	2	Qgd	-	655	Wf 36	Flows
	32-2	SW	SW	Silver Creek Station	--	--	22	3	Qgd	P	680	---	Flows
	32-3	SW	SW	do.	--	--	38	4	Qgd	P	682	Wf 1	Flows
	32-4	SW	SW	Silver Creek Lodge	--	--	40	2½	Qgd	P	685	Wf 41	Flows
	32-5	SW	SW	do.	--	--	30	2½	Qgd	P	685	Wf 42	Flows
48N 2E	26-1	NW	SW	Hamilton's Lodge	Ulric Mayer	1955	35	4	Css	P	595	--	Bedrock at surface; Water reported soft
	26-2	SW	NE	Payment School	--	--	300	5	--	-	--	Sg 1	
47N 7W	11-1	SE	NW	Tom McCary	Ulric Mayer	1948	297	2	Qgd	-	856	Wf 34	
47N 6W	5-1	NW	NW	Chan Elliot	Leonard Ellis	1949	44	2	Qgd	-	710	Wf 37	Flows
	5-2	NW	NW	Jos. Graham	J. T. Smith	--	63	2	Qgd	D	745	--	Water reported good
	5-3	NW	NW	do.	do.	--	63	2	Qgd	D	740	--	Water reported good
	14-1	SW	SE	U. S. Forest Service	George Brunner	1939	43	5	Qgd	P	630	Wf 32	Flows
	18-1	NE	SE	Falls Motel	V. Smith	--	86	2	Qgd	P	851	--	Water reported good
47N 5W	18-1	SE	SW	Neomi Kong Club	--	--	--	--	--	P	633	--	Flows
	23-1	SW	SW	U. S. Forest Service	George Brunner	1940	30	5	--	P	615	Bm 5	
	33-1	SW	NW	do.	do.	1937	258	5	--	P	1,065	Bm 6	
47N 4W	24-1	SW	NW	do.	--	1939	31	5	Qgd	P	620	Bm 11	
	25-1	NE	SW	Van Leuven	--	--	140	--	Qgd	D	825	Bm 3	
	25-2	--	--	U. S. Forest Service	--	--	203	--	Qgd	P	830	--	
	28-1	NW	NW	U. S. Fish Hatchery	J. T. Smith	1951	98	4	--	P	611	--	
	28-2	SW	NW	do.	Layne-Northwest	--	180	6	Qgd	P	620	--	Water reported good

Well designation T.R.	sec.-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
47N 3W	10-1	SW	NW	W. Weston	--	--	128	--	Qgd	D	610	Bm 14	Bedrock at 128 ft.
	11-1	--	--	Henry Bosley	--	--	--	--	--	D	640	--	Spring
	12-1	NE	SW	P. T. Routhier	Douglas Holzem	1955	66	6	Qgd	D	624	--	Water reported good
	12-2	SW	NW	U. S. Coast Guard	--	--	20	--	--	P	612	--	
	15-1	SW	NW	U. S. Forest Service	George Brunner	1939	370	5	Css	P	1,010	Bm 10	Bedrock at 365 ft.
	30-1	NW	NW	Dollar Settlement School	--	--	30	1¼	Qgd	P	740	Bm 2	
	30-2	SW	SE	Peter Shields	--	--	10	36	Qgd	S	870	--	
47N 2W	26-1	--	SW	James Henderson	--	1935	38	2	Qgd	D	610	Bm 4	
	29-1	SE	SW	Downs	Downs	1955	162	2	Qgd	D	608	--	Flowed; Well destroyed
	29-2	SE	SW	George Keller	--	--	50	2	Qgd	D	608	--	Flows
	30-1	NE	NE	Leo LaBlanc	--	--	160	2	--	D	610	Bm 7	Flows
	30-2	NW	NE	Kinney's Store	--	--	160	--	Qgd	D	620	--	
	31-1	NW	SE	Elmer Weiland	--	--	66	--	Qgd	-	620	Sp 57	Flows
	31-2	NW	SE	A. Pomeranky	A. Pomeranky	1955	75	2	Qgd	P	610	--	Flows; Water reported good
	34-1	SE	SW	H. M. Edmunds	H. M. Edmunds	--	328	2	Css	-	609	Bm 1	Flows; Well destroyed
	34-2	SE	SW	do.	do.	--	292	3	--	-	610	--	Flows; Unfinished
	34-3	SE	SW	do.	do.	1930	285	3-2	--	D	610	--	Flows; Water reported hard
	34-4	NE	SE	C. Miller	--	--	103	--	Qgd	D	610	Bm 16	
	34-5	NE	SE	Hankenon	--	1943	88	2	Qgd	D	610	--	Flows
	34-6	NE	SE	Henry Smith	--	--	129	2	Qgd	D	610	--	Flows; Water reported good
	34-7	--	--	--	H. M. Edmunds	1945	262	--	Qgd	-	--	--	
	34-8	--	--	Penman	do.	--	109	2	Css	D	--	--	Flows
	35-1	SW	SE	C. I. White	--	--	84	--	Qgd	D	680	Bm 19	
	35-2	NE	NW	Emery Pierce	--	--	42	2	Css	D	608	--	Water reported good
	35-3	NE	NW	J. Andary	--	--	47.5	4	--	D	608	--	
47N 1W	11-1	NE	NE	Cadillac Lumber and Chemical Co.	W. S. Cater	1923	998	-	Css	I	640	So 44	MDC log; Water reported good
	11-2	SW	NE	John Davis	--	--	14	1¼	--	D	--	So 9	
	11-3	SW	NE	Gus Martin	--	--	20	48	--	D	--	So 34	
	13-1	NE	SE	--	Jack Meehan	--	70	--	Css	D	700	So 41	Bedrock at 70 ft.
	14-1	SE	SE	Larke School	--	--	44	4	Qgd	P	765	So 38	
	14-2	SE	SE	C. H. Walker	--	--	50	46	--	P	760	So 39	
	14-3	NW	NW	William Kellis	Douglas Holzem	1955	57	4	Css	D	650	--	Bedrock at 52 ft.; Iron reported in water
	14-4	SW	SE	Northern Sand and Gravel Co.	do.	1955	201	8	Qgd	I	762	--	
	22-1	NE	NE	J. Bysiek	--	--	--	36	Qgd	D	720	--	Water reported good
	23-1	NE	NE	U. S. Corps of Engineers	Layne-Northwest	--	1,595	8	Css	-	760	--	Not used
	23-2	NW	SE	E. Harwood	Douglas Holzem	--	99	6	Qgd	D	760	--	
	23-3	NE	NE	U. S. Air Force	--	--	193	6	Qgd	P	760	--	Water reported good
	23-4	NE	NE	do.	--	--	160	6	Qgd	P	760	--	Water reported good
	24-1	SE	SW	George McDonald	--	1945	90	3	--	P	715	So 7	
	24-2	SE	NW	George McKay	George McKay	1954	80	2	Qgd	D	715	--	Water reported soft
	24-3	SE	NW	Lamoroaux	Douglas Holzem	1955	84	6	Qgd	D	715	--	
	24-4	SE	NW	Bonabucci	do.	1955	130	6	Css	D	715	--	
	24-5	SE	NW	C. M. Smith	do.	1955	123	6	Css	D	715	--	Bedrock at 114 ft.
	24-6	NE	NW	City Limits Cabin	J. T. Smith	1950	120	4	Qgd	P	706	--	
	26-1	SW	NW	Baker School	--	--	44	3	--	P	718	So 5	
	28-1	SW	SW	M. Brabant	Jack Meehan	--	197	2	Qgd	-	630	--	Flows; Well not used
	28-2	SE	SE	J. Senogles	do.	--	187	2	Qgd	D	640	--	Formerly flowed
	32-1	SE	SW	J. Byers	--	--	104	2	--	D	655	So 6	
	32-2	SE	SE	Webert White	Ulric Mayer	1949	190	4	Css	D	663	So 10	Water reported hard
	33-1	NW	NE	A. Caufield	--	--	167	--	--	-	650	So 56	Bedrock at 167 ft.
	33-2	NW	NW	do.	--	--	213	--	Qgd	-	640	So 55	
	33-3	SW	SE	A. Pajula	A. Pajula	--	35	30	Qgd	D	650		
	34-1	NE	NW	H. Smart	--	--	--	2	Qgd	D	647	--	Flows
	35-1	NW	NW	A. A. Abbott	--	--	40	--	--	-	700	So 57	
47N 1E	6-9	SE	SE	Soo Creamery	Litzner and Son	1940	140	6	--	I	610	So 12	
	9-1	SE	NE	U. S. Coast Guard	Herman	1929	195	3	Css	-	590	--	Water reported saline
	9-2	SE	SE	Basil Smith	Douglas Holzem	1955	96	[illegible]	Qgd	D	590	--	Water reported reddish
	10-1	NE	SE	Emil Autio	Ulric Mayer	1955	189	4	Qgd	D	588	--	Bedrock at 189 ft.; Water reported salty
	10-2	SE	SE	Carlson Motel	do.	--	73	4	--	P	590	--	Water reported salty
	10-3	SE	SE	C. Rickena	C. Rickena	--	70	2	Css	-	590	--	Water reported salty
	11-1	NW	NW	--	Litzner and Son	--	52	6	Css	D	590	Sg 10	Flows
	12-1	NW	SW	J. A. Adams	Ulric Mayer	1955	198	4	Css	D	597	--	Bedrock at 140 ft.
	15-1	SW	SW	City of Sault Ste. Marie	do.	--	--	4	Css	P	605	--	Flows; Water reported good
	16-1	NE	NE	--	Douglas Holzem	--	87	4	Qgd	D	590	--	Flows
	17-1	SE	SW	Harold L. Root	Ulric Mayer	--	122	4	Css	D	680	--	Bedrock at 106 ft.
	18-1	NW	NE	Paul McClinchey	Paul McClinchey	1949	42	-	Qgd	-	700	So 40	Well reported dry
	19-1	NW	NE	Robert Rawling	Douglas Holzem	1955	67	6	Qgd	D	707	--	
	19-2	SE	NW	Martin Brock	J. T. Smith	1955	133	4	Css	D	707	--	Bedrock at 97 ft.

Table 2.--Records of wells and test holes in Chippewa County.--continued

Well designation T.R.	sec-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
47N 1E	21-1	NE	NE	J. C. Mills	Jack Reed	--	52	2	Qgd	D	615	--	Water reported good
	21-2	SE	NE	Edward Guillard	Douglas Holzem	1955	265	6	Css	-	624	--	Water reported saline
	21-3	SW	NW	S. J. Bottrell	Ulric Mayer	1955	--	4	Css	D	691	--	Water reported reddish
	22-1	SW	NW	A. Robbins	do.	--	156	4	Css	D	620	--	Water reported good
	22-2	NE	SE	Riverview Store	Riverview Store	--	38	2	Qgd	P	595	--	Flows; Water reported good
	23-1	SW	SW	J. A. Brocklehurst	Douglas Holzem	1955	175	6	Css	D	590	--	Bedrock at 167 ft.; Flows; Water reporte reddish
	23-2	SW	SW	Pratt Cabins	Ulric Mayer	1949	204	2	Css	P	600	So 11	Flows
	24-1	SE	SW	--	Jack Meehan	--	50	4	Qgd	D	710	So 47	
	26-1	SE	SW	Riverside School	--	--	80	2	--	P	600	So 4	
	26-2	SE	NW	Taffy Abel	--	1947	148	2	--	P	590	So 43	
	27-1	NE	NE	Atkinson	Ulric Mayer	1949	75	2	Qgd	D	620	So 51	
	27-3	NW	SW	Gardenville School	--	1942	140	--	Qgd	P	630	So 1	
	27-4	NW	SW	do.	--	--	65	2	--	P	630	So 2	
	27-5	NW	SW	do.	--	--	35	12	--	P	630	So 3	
	27-6	SW	SW	John Cox	--	--	32	12	--	D	632	So 27	
	27-7	SE	SE	Raymond Eagle	Raymond Eagle	--	24	--	Qgd	D	640	--	Water reported good
	28-1	SE	NE	G. M. Cuthbert	--	--	48	--	Qgd	D	630	So 25	
	28-2	SE	NE	do.	Ulric Mayer	1949	280	4	Css	D	630	So 26	
	32-1	NW	NW	Pine Rest School	--	--	--	1½	Qgd	P	701	--	
	33-1	NW	NE	Anthony Baldino	--	--	36	1½	Qgd	S	641	--	Flows
	33-2	NW	NW	Vic Hillock	Ulric Mayer	1952	218	4	Css	D	685	--	Bedrock at 74 ft.; Water reported good
	35-1	SW	NW	James Eagle	do.	--	83	--	Css	D	620	So 9	Poor yield
	35-2	SW	SW	M. McGuire	--	--	11	36	Qgd	D	618	--	
46N 7W	15-1	--	--	Old Lumber Camp	Jas. Somerville	1905	90	--	--	-	--	Wf 45	
	26-1	NE	SW	Hulbert School	--	1924	87	3	Qgd	P	815	Hb 1	
	36-1	SW	SW	H. W. Agnew	--	1943	108	2	--	-	850	Hb 4	
46N 6W	3-1	NW	SE	H. M. Edmunds	H. M. Edmunds	--	143	2	Qgd	D	820	--	
	22-1	SE	NW	Frank LaFex	--	--	64	1½	--	P	750	Cp 13	Flows
	22-2	--	--	Lake Livery Stable	Lake	--	35	--	Qgd	P	--	Cp 31	Flows
	22-3	NE	SW	Sheldon Lumber Co.	Leonard Ellis	1949	96	2½	Qgd	-	760	Cp 14	Flows
	22-8	NW	SE	F. Brissett	F. Brissett	--	35	--	Qgd	D	775	Cp 30	Flows
	22-9	NW	SE	Eckerman School	--	1919	100	--	Qgd	-	771	Cp 3	Flows
	22-10	SE	NW	Tuttie LaFex	Leonard Ellis	1949	52	2	Qgd	-	750	Cp 12	Flows; Water reported hard
	22-11	--	--	George Johnson Hotel	Jas. Somerville	1896	47	3	Qgd	P	803	Cp 22	Flows
	34-1	NE	NE	Bernin Clark	--	--	63	2	Qgd	-	860	Cp 15	
	35-1	SW	NE	U. S. Forest Service	George Brunner	1938	118	5	Qgd	P	950	Cp 6	
46N 5W	25-1	SE	SE	do.	--	1940	22	5	Qgd	P	900	Cp 7	Equipped with screen.
	25-2	NE	SE	do.	--	1940	23	5	Qgd	P	900	Cp 8	Equipped with screen.
	25-3	NE	SE	do.	--	1940	24	5	Qgd	P	900	Cp 9	Equipped with screen.
	28-1	SW	SW	R. DeWeese	J. Mills	1936	58	2	Qgd	P	870	--	
	29-1	SE	SE	do.	Dier	--	52	2	Qgd	P	870	--	
	29-2	SW	SW	William Kulean	--	--	47	2	Qgd	-	845	Cp 11	
	29-3	SW	NW	Strongs School	--	1921	16	5	Qgd	P	813	Cp 5	
	29-4	SW	NW	do.	--	1933	80	--	Qgd	P	813	Cp 4	Flows
	29-5	NW	SW	Chippewa Twp. Hall	Leonard Ellis	--	63	2	Qgd	P	850	Cp 10	
	30-1	--	NE	Turner's Boarding House	Jas. Somerville	1899	203	2	Qgd	P	830	Cp 1	Flows
	30-2	--	NE	Turner's Mill	do.	1899	220	2	Qgd	I	825	Cp 2	Flows
	31-1	NE	NW	R. DeWeese	--	--	45	2	Qgd	D	880	--	
	32-1	NW	NW	Schnepps	--	--	60	2	--	P	870	Cp 18	
46N 4W	2-1	NE	SW	U. S. Forest Service	--	1937	155	5	Qgd	P	890	Sp 14	Equipped with screen.
	20-1	SW	SE	do.	--	1937	58	5	Qgd	P	915	Sp 13	
	24-1	NE	SE	do.	--	--	54	6	Qgd	O	850	Sp 59	
	28-1	NW	SE	U. S. Air Force	R. Dunbar	1942	59	8	Qgd	P	907	Sp 36	
	28-2	--	--	do.	Tom Rice	--	82	--	Qgd	P		Sp 36	
	29-1	NE	NW	D.S.S. and A.R.R. Station	--	--	45	--	Qgd	P	910	Sp 54	
	30-1	--	--	U. S. Army	--	1900	45	--	Qgd	P	920	Sp 37	
	30-2	--	--	do.	--	1935	40	36	--	P		Sp 38	
	33-1	NW	NW	U. S. Air Force	--	--	--	2	Qgd	O	908	--	
46N 3W	13-1	SE	SE	H. Mills	--	--	55	6	Qgd	-	707	Sp 28	Well not used.
	16-1	--	SW	D.S.S. and A.R.R. Co.	--	1885	280	8-6	Qgd	-	815	Sp 56	
	19-1	NE	NE	H. Roth	--	--	63	--	Qgd	-	840	Sp 31	
	19-2	NE	NE	Raco School	--	--	40	4	Qgd	P	840	Sp 3	
	19-3	NE	NE	Mrs. George Kinsella	--	--	50	1¼	Qgd	-	840	Sp 4	

Table 2.--Records of wells and test holes in Chippewa County.--continued

Well designation T.R.sec-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
46N 3W 22-1	NW	NE	H. Donnay	--	--	55	--	Qgd	-	700	Sp 19	
26-1	NE	NE	Jones-Schumaker	Jones-Schumaker	1954	167	2	Qgd	D	700	--	Flows; Bedrock at 164 ft.
46N 2W 1-1	NW	NE	Marshall Forrest	Marshall Forrest	1955	126	2	Qgd	D	666	--	Water reported good
1-2	NW	NE	do.	--	--	30	--	Qgd	S	666	Sp 26	
3-1	NW	NW	Norman Byers	Frank Villo	1940	200	2	Qgd	D	615	--	Flows; Water reported good
4-1	NW	NE	Mich. Dept. of Conserv.	--	1930	392	4	Qgd	P	605	Sp 24	Flows
4-2	SW	NW	Hannas	--	--	416	--	Qgd	-	620	Sp 22	Flows
4-3	NW	SW	Milligan	--	--	385	2	Qgd	D	610	--	Flows
4-4	SW	SW	Village of Brimley	--	1914	392	2	Qgd	P	650	Sp 6	
4-5	SW	SW	Superior Twp. Hall	A. M. Glass	1938	729	6	Css	P	650	Sp 5	Well abandoned
4-6	NW	SW	L. Ladd	--	--	385	--	Qgd	-	620	Sp 12	
4-7	NW	SW	Lazy Bob's Tavern	--	--	426	--	Qgd	-	620	Sp 11	Flows
4-9	NW	NE	Brimley State Park	--	--	300	--	--	P	610	Sp 13	Well abandoned
5-1	SE	NE	Alex Goldade	Alex Goldade	--	410	2	Qgd	D	620	Sp 9	Flows; Water reported good
5-2	SW	NW	G. Anderson	McCready	--	166	2	Qgd	D	610	--	Flows; Water reported good
5-3	SE	NE	Atkinson	--	--	185	3	Qgd	-	620	Sp 30	Flows
5-4	SW	NW	McCready	McCready	--	140	2	Qgd	D	620	--	Flows; Water reported good
6-1	SE	NE	--	--	--	186	--	--	-	620	Sp 35	Bedrock at 182 ft.
8-1	NE	NE	Sup. Twp. Rural Agr. High School	--	--	325	6	--	-	655	Sp 1	
8-2	NE	NE	do.	--	--	42	4	Qgd	P	655	Sp 2	Well abandoned
8-3	NW	NE	Don Charles	--	--	35	12	Qgd	D	670	--	Well abandoned
11-1	SW	NW	--	--	--	300	--	--	-	640	Sp 58	Bedrock at 300 ft.
12-1	NE	NW	J. Cottelit	--	--	181	--	Qgd	D	655	Sp 17	Bedrock at 181 ft.
15-1	SW	SW	V.F.W. Hall	V.F.W. members	1952	418	2	Qgd	P	635	--	Flows; Bedrock at 400 ft.; Water reported good
16-1	NW	NW	I. Mills	--	--	240	--	Qgd	-	669	Sp 29	
16-2	SW	NW	E. Sutton	--	--	102	--	--	-	675	Sp 34	Bedrock at 96 ft. (?)
16-3	NE	SE	T. Burchill	J. T. Smith	1955	355	2	Qgd	-	641	--	
16-4	SW	SE	A. J. Hill	--	--	97	--	--	-	657	Sp 23	
17-1	SE	SE	A. J. Preoille	--	--	82	8	--	P	684	Sp 10	Bedrock at 72 ft.
18-3	SW	SE	J. Rurk	--	--	39	--	--	-	700	Sp 32	Bedrock at 30 ft.
18-4	--	SW	--	Jack Meehan	--	40	4	--	-	685	Sp 26	Bedrock at 40 ft.
19-1	SE	NE	--	--	--	--	24	Qgd	O	695	--	
20-1	NE	NE	M. Willette	Ulric Mayer	1955	73	4	Qgd	D	684	--	
20-2	SE	NE	Arthur Gamelin	--	--	63	48	Qgd	-	685	Sp 20	
20-3	NW	NW	Tinsley	--	--	24	--	--	-	690	Sp 39	
22-1	SE	NE	Clarence Johnson	J. T. Smith	1955	410	4	Qgd	D	630	--	Flows; Water reported clear
23-1	NW	SW	Archie McLean	--	--	315	--	--	-	640	Sp 25	
24-1	SW	SW	Joe Schwiderson	--	--	111	--	--	-	657	Sp 33	
25-1	NW	NW	R. Craven	--	--	125	--	Qgd	D	657	Df 25	
25-2	SE	SE	Larch Community Church	--	--	28	18	Qgd	P	682	Df 6	
26-1	SW	SW	L. Ackinson	--	--	--	2	Qgd	S	660	--	Flows
27-1	SW	NW	F. Schwiederan	J. T. Smith	--	394	2	Qgd	D	630	--	Flows
28-1	NE	SE	Bound Farm	--	--	302	--	Qgd	-	630	Sp 16	
28-2	SE	SE	C. A. Nesseth	--	--	306	2	Qgd	D	625	--	Flows; Water reported good
34-1	NW	NW	Russel Goodeman	--	--	--	2	--	D	638	--	Flows
34-2	SW	SE	D. Wilson	Sparks	--	235	2	Qgd	D	640	--	Flows
46N 1W 1-1	SW	SE	C. Dean	--	--	135	--	Css	-	670	Df 45	
2-1	NE	SE	L. Mansfield	--	--	139	--	--	-	672	Df 44	Bedrock at 139 ft.
2-2	NW	NW	J. H. Smart	--	--	108	--	--	-	674	Df 43	Bedrock at 108 ft.
2-3	NE	NW	Roy Wagner	--	--	60	2	Css?	D	680	Df 5	
2-4	SW	SW	A. Doran	--	--	--	--	Qgd	-	650	--	Flows
2-5	SE	SW	Gus Forrest	--	--	--	2	--	D	652	--	Flows
3-1	NE	NW	P. Hassard	--	--	157	--	--	-	650	Df 42	Bedrock at 157 ft.
3-2	SW	SW	Austie Huttlinen	J. T. Smith	1955	113	4	Qgd	D	656	--	Flows; Water reported good
5-1	NE	NW	J. B. Byers	--	1924	123	2	--	-	650	Df 1	
7-1	SE	NE	L. E. Pedrin	--	--	108	2	--	D	650	Df 4	
10-1	SE	SE	W. Lounds	W. Lounds	--	--	2	Qgd	D	655	--	Flows
11-1	NW	NE	R. Montgomery	--	--	--	--	Qgd	D	665	--	Flows
11-2	NW	NE	Osen Johnson	--	--	--	2	Qgd	D	655	--	Flows
11-3	NE	NW	Jerry Bonnie	--	--	--	--	Qgd	D	655	--	Flows
12-1	SW	SE	M. O'Brien	J. T. Smith	--	164	4	Qgd	D	660	--	
13-1	NE	NE	Bill Hill	do.	1949	188	--	Qgd	D	650	Df 17	
14-1	NE	NE	P. Stickles	P. Stickles	1910	165	2	Qgd	D	660	Df 10	Flows
14-2	--	NW	B. McEvoy	--	1880	45	--	--	-	650	--	Flows
14-3	SE	NW	Dr. R. Jewell	--	--	25	42	Qgd	D	655	--	Flows
14-4	NW	NE	C. L. Royer	Walter Litzner	1948	148	4	Qgd	P	660	Df 8	Water reported good
16-1	SW	SW	Clayton Wilson	J. T. Smith	1955	84	4	Qgd	D	680	--	
18-2	SE	SE	Noble Graham	--	--	50	3	--	D	650	Sp 21	
20-1	NE	NW	Sommerville School	--	1933	160	2	Qgd	-	655	Df 3	Flows

Well designation T.R.sec.-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
46N 1W 20-2	NW	NW	--	J. T. Smith	--	148	--	Qgd	D	650	Df 18	Flows
22-1	NW	NE	Cloverland R.E.A.	Douglas Holzem	--	143	6	Qgd	I	680	--	
22-2	SW	SW	M. Young	J. T. Smith	--	110	4	Css	D	692	--	Bedrock at 105 ft.
22-3	SW	SW	John Smith	do.	--	70	--	Qgd	D	690	Df 20	
22-4	SW	SW	--	do.	--	64	--	Css	D	690	Df 21	
22-5	SW	SE	Dafter Inn	Jack Meehan	1942	140	4	Qgd	P	696	Df 16	Bedrock at 140 ft.
23-1	NE	NE	Dr. Baker	J. T. Smith	--	182	2	Qgd	D	655	--	Flows
24-1	SE	SE	Elmer Peterkin	--	--	--	--	--	D	642	Df 15	Flows
24-2	SE	SE	Reid Crawford	J. T. Smith	--	218	2	--	D	642	--	Flows
25-1	SE	SE	--	W. P. Roe	--	220	2	--	-	650	Br 53	Flows
26-1	NE	NW	Hugh Miller	Douglas Holzem	1955	34	6	Qgd	D	690	--	
26-2	SE	SE	--	W. P. Roe	--	60	2	Qgd	D	700	Df 22	
28-1	NW	SW	Ray Follis	J. T. Smith	--	165	2		D	654	Df 19	Flows
28-2	SW	SW	Clayton Norton	--	--	97	--	--	-	667	Df 47	Flows; Bedrock at 97 ft.
29-1	SW	SE	Bailey Suggitt	J. T. Smith	--	102	2	Qgd	D	673	--	
32-1	NE	NE	W. R. Beamish	--	--	--	2	Qgd	D	670	--	Flows
32-2	NE	NW	A. J. Norton	--	--	80	--	--	-	680	Df 41	Bedrock at 80 ft.
32-3	NW	SW	Aggie McKiddie	--	1920	36	2	Qgd	D	700	Df 23	
32-4	NW	SW	do.	J. T. Smith	--	148	--	Qgd	D	700	Df 24	Flows
32-5	SE	SE	Bailey Suggitt	do.	--	40	2	--	S	680	--	Flows
33-1	NW	NE	J. Snider	do.	--	45	4	Qgd	D	683	--	Flows
33-2	SW	SE	Wilson's Cabins	Douglas Holzem	--	51	4	Qgd	P	710	--	Water reported good
33-3	SE	SW	G. Graham	do.	--	77	6	Qgd	D	700	--	
34-1	NE	NW	J. Logan	do.	--	75	4	Ols	D	700	--	
34-2	NW	SW	Christie School	--	--	30	8	--	P	700	Df 2	
36-1	SE	SE	--	J. T. Smith	--	60	--	Qgd	-	665	Dr 52	Flows
46N 1E 2-1	NW	SW	--	Douglas Holzem	1955	89	6	Css	D	612	--	Bedrock at 40 ft.
2-2	NE	NE	L. R. Mitchell	--	--	109	2½	--	P	588	Br 36	
7-1	NE	NW	Wesley Sheppard	Wesley Sheppard	--	22	48	Qgd	D	690	Br 60	
7-2	SE	NW	P. Sheppard	--	--	40	--	Qgd	D	680	Br 61	
8-1	NE	NE	Joseph Long	--	--	40	60	Qgd	-	684	Br 9	
8-2	NE	SE	J. R. Cullis	Frank Villo	1949	68	2	Qgd	D	675	Br 59	Bedrock at 68 ft.
8-3	NE	SE	do.	J. T. Smith	1955	190	4	Css	D	676	--	Bedrock at 76 ft.; Water reported saline
8-4	NE	SE	do.	Bill Hayden	--	35.5	48	Qgd	D	676	--	Water reported good
10-1	SE	SE	Fred Arnott	--	--	--	36	Qgd	D	606	--	
13-1	SW	SW	J. W. Hinds	--	--	100	--	Qgd	-	590	Br 34	
16-1	SW	SW	--	Harry Yirs	--	140	2	Qgd	-	638	Br 47	
18-4	NW	SE	Ransomville School	--	--	90	2	--	P	650	Br 5	Flows
19-1	NW	SW	James McKee	--	1921	211	2	Qgd	-	640	Br 32	
20-1	NE	NE	J. P. Campbell	J. P. Campbell	--	22	42	Qgd	D	640	--	Water reported good
21-1	NE	NW	Edgar Spencer	--	--	45	--	--	P	640	Br 8	
22-1	NE	NE	Truman Mitchell	--	--	--	48	Qgd	D	615	--	
23-1	NW	NE	Grier School	--	--	40	10	Qgd	P	610	Br 7	
24-1	NW	SW	Stanley Fletcher	Stanley Fletcher	--	72	2	Qgd	D	605	--	Water reported good
25-1	--	NW	John Baylus	--	--	80	--	Qgd	-	610	Br 18	
26-1	NW	NE	Jacob Wright	--	--	78	--	Qgd	-	610	Br 19	
30-1	SW	SW	Edward Dunbeck	J. T. Smith	--	230	--	--	D	650	--	Flows
31-1	SW	NW	Parkerville School	--	--	100	2	--	P	650	Br 4	Flows
31-2	SW	NW	Clyde Savyers	--	--	15	48	--	P	650	Br 3	
31-4	NW	SW	James Donnelly	--	1901	--	2	--	D	650	--	Flows; Water reported good
31-7	SW	SW	Robert McKee	Judson Daly	1905	78	2	Qgd	P	640	Br 24	Flows
35-1	SW	NW	McCarron Church	Ulric Mayer	1949	116	4	Oss?	-	670	Br 50	
35-2	SW	SE	McCarron School	--	--	22	2	--	P	667	Br 11	
46N 2E 36-1	SW	SW	Julius Schultz	--	1939	26	3	--	D	645	Sg 5	
45N 5W 6-1	NW	NE	C.C.C. Camp	--	--	--	6	--	P	--	Kr 2	
6-2	SE	SW	U. S. Forest Service	George Brunner	1940	25	5	--	P	880	Kr 5	
6-3	SE	SW	do.	do.	1940	22	5	--	P	880	Kr 6	
27-1	NW	SE	do.	do.	1940	31	5	--	P	875	Tk 4	
45N 4W 6-1	SE	NE	do.	do.	1939	28	5	Qgd	P	790	Kr 7	
25-1	SW	NE	--	--	--	15	8	Qgd	D	710	--	
45N 3W 19-1	SW	NW	Camp Bear Born	--	--	9.3	30	--	D	704	--	
45N 2W 4-1	NE	NE	J. Vanderstaar	J. T. Smith	--	206	4	Qgd	D	655	--	Flows
16-1	NE	NE	Howard Pope	--	--	150	--	Qgd	-	750	Kr 15	
18-1	SE	NE	R. VanSlooten	--	--	70.5	2	Qgd	D	792	--	Water reported good
18-2	NE	SE	White Lumber Co.	--	--	100	--	--	-	800	Kr 23	
20-1	NW	NW	Rudyard Cemetery	--	--	125	--	Qgd	-	790	Kr 16	
20-2	NW	SW	--	--	--	--	3	Qgd	-	746	--	
20-3	NW	SW	I. Postma	--	--	100	--	Qgd	-	760	Kr 11	
21-1	SW	NW	Elmer Nelson	--	--	--	2	Qgd	-	715	--	Flows
23-1	NE	SE	--	Jack Meehan	--	62	--	Qgd	-	750	Kr 26	

Well designation T.R.	sec.-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
45N 2W	23-2	SW	SE	Kinross School	--	--	85	2	--	-	760	Kr 1	
	24-1	SE	NW	A. L. Litzner	Walt Litzner	1948	43	3	Qgd	-	740	Kr 18	Water reported good
	25-1	SE	NW	4H Camp	Jack Meehan	--	84	4	Qgd	-	790	Kr 12	
	26-1	NE	NW	V. LaJoice	V. LaJoice	1955	31	1¼	Qgd	D	749	--	
	27-1	NW	SW	Elvin Hixon	--	--	--	--	--	-	700	Kr 24	Flows
	29-1	NW	SW	--	Harry Yirs	--	120	4-2	Qgd	-	708	Ry 134	Flows
	29-2	SW	NW	--	--	--	132	--	Qgd	-	711	Ry 15	
	30-1	SW	SW	E. C. Edgerly	Harry Yirs	--	184	2	Qgd	D	700	--	
	30-2	SE	SE	Holland School	do.	--	100	2	--	-	708	Ry 6	Flows
	31-1	NE	NE	Henry Hesselink	--	1916	148	2	Qgd	-	708	Ry 122	Flows
	31-2	SE	NE	L. A. Halbert	John Kamper	1905	118	2	Qgd	D	705	Ry 55	Flows
	31-3	SE	SE	Holland Church	Harry Yirs	--	135	--	Qgd	-	700	Ry 25	
	32-1	NE	NW	G. Kamper	G. Kamper	1905	90	2	Qgd	-	720	Ry 56	Flows
	32-2	SW	SE	C. A. Williams	--	--	28	2	--	D	716	--	
	32-3	SW	SW	John Kamper	John Kamper	--	90	1	Qgd	D	700	Ry 57	Flows
	32-4	SW	SW	do.	do.	--	100	1	Qgd	D	700	Ry 58	
	33-1	SE	SW	William MaKaranien	--	--	50	3	Qgd	O	716	--	
	33-2	SE	SW	J. Bosma	Harry Yirs	--	51	2	Qgd	-	715	--	
	33-3	SE	SE	William Johnson	Garret Dolman	1905	68	3	Qgd	-	695	Ry 96	Flows; Water reported sulfurous
	34-1	NW	NW	J. E. Mackie	--	--	--	2	Qgd	D	690	--	Flows
	34-2	SW	SW	William Larsen	--	--	--	2	--	D	690	--	Flows; Water reported good
	36-1	NW	NW	--	--	--	187	--	Qgd	-	710	Kr 8	
45N 1W	4-1	SW	NW	Hall's Cabins	Glass	--	63	6	Qgd	P	720	--	Water reported good
	12-1	SE	SE	Green School	--	--	100	2	--	P	695	Br 6	
	28-1	SE	NE	Jackson Fletcher	--	--	76	--	--	-	800	Kr 19	
	28-2	SE	SE	L. Black	L. Black	1955	82	2	Qgd	D	795	--	
	29-1	SW	SW	U. S. Air Force	Milager	1952	125	16	Qgd	P	795	Kr 14	Water reported good
	29-2	SW	SW	do.	do.	--	155	16	Qgd	-	790	--	Well destroyed
	29-3	SW	SW	do.	do.	1952	137	16	Qgd	P	790	--	
	29-4	SE	SW	do.	do.	--	147	16	Qgd	-	790	--	Well destroyed
	31-1	SW	NW	do.	Ulric Mayer	1943	162	4	Qgd	P	790	Kr 14	
	31-2	SE	NE	do.	do.	--	--	4	--	P	790	--	
	33-1	SE	NW	Kinross C.C.C. Camp	Jack Meehan	--	144	4	Qgd	-	795	Kr 9	
	34-1	NW	NW	Wilson School	--	--	85	2½	--	-	795	Kr 3	
45N 1E	2-1	NW	NE	Avery	Ulric Mayer	1949	65	4	Qgd	-	620	Br 51	
	4-1	NE	NE	David McCarron	--	--	30	--	Qgd	D	663	Br 38	Flows: Water reported sulfurous
	4-2	NE	NE	W. McCarron School	--	--	--	18	--	P	663	Br 10	
	11-1	NW	NW	E. R. Newcomb	--	--	55	2	Qgd	D	642	--	
	13-1	SW	SE	Mary Ellen Plount	--	--	23	48	--	-	655	Br 33	
	13-2	--	SW	Walter Atkins	--	1951	146	22	Qgd	D	660	--	Flows
	14-1	SW	SE	--	--	--	73	--	Ols	-	677	Br 64	Bedrock at surface
	15-1	NE	SE	Dave Mitten	--	--	30	48	Qgd	D	689	--	Water reported good
	17-1	SE	SW	--	--	--	--	2	Qgd	S	655	--	Flows
	18-1	--	NE	McKee Exploration Club	Bowman Oil Co.	1940	587	8	--	-	694	Br 13	MDC log 7852
	22-1	SE	NE	William Mitten	--	--	123	2	Ols	-	650	Br 63	Flows
	23-1	NE	NE	Clarence Scale	--	--	30	2	--	-	680	Br 2	
	23-2	NW	NW	do.	--	--	40	30	--	D	676	--	
	23-3	NW	SW	--	--	--	40	--	--	-	635	Br 65	Flows
	34-1	NE	NE	Mrs. LaJoie	--	--	35	6	Qgd	D	618	--	
	35-1	SW	NW	--	--	--	120	--	Qgd	-	624	Br 69	
	35-2	SW	NW	Park School	--	--	90	2	--	P	622	Br 1	
45N 2E	3-1	NE	SE	U. S. Coast Guard	--	--	72	4	--	D	590	--	
	6-1	NW	SE	Mich. State Univ.	--	1910	103	2	Qgd	-	590	--	
	6-2	SE	SE	do.	--	1910	70	2	Qgd	P	595	--	
	6-3	SE	SE	do.	Ulric Mayer	1949	96	2	Qgd	P	590	Br 15	
	6-4	SW	SE	do.	do.	1949	65	4	Qgd	P	595	Br 17	
	6-5	SW	SE	do.	do.	1949	33	3	Qgd	P	585	Br 16	
	6-6	SE	SE	do.	Jack Meehan	1940	132	2	Qgd	-	585	Br 14	Flows
	15-1	SW	SE	Soo Twp. School	--	--	28	2	--	P	665	So 38	
	18-1	--	--	Oscar Brander	W. J. Rodgers	1946	92	--	Qgd	-	683	Br 26	
	18-2	SW	SW	A. C. Hube	A. C. Hube	--	20	48	Qgd	D	672	--	
	19-1	NE	NE	Jack Hammond	--	--	40	2	--	-	595	Br 31	
	19-2	NW	NE	Percy Campbell	Jack Meehan	--	110	2	Qgd	D	610	--	Water reported good
	20-1	SW	SE	Rock Cut School	--	--	90	1½	--	P	600	Br 12	Water reported "no good"
	26-1	SE	SE	Fred Parr	--	--	12	1½	--	P	620	So 21	
	29-1	SW	NE	Francis O'Neill	W. J. Rodgers	1946	57	--	--	-	660	Br 27	Water reported "no good"
	33-1	NW	NW	Mominee's Resort	--	1938	29	2	--	P	595	Br 57	
	33-2	SE	SW	A. H. Schmidt	--	1938	115	4	--	P	595	Br 30	Flows
	33-4	NW	SE	Edward Doll	W. J. Rodgers	1946	41	--	--	-	600	Br 25	
	33-5	NE	SE	Ervin and Gardner	do.	--	42	6	--	-	600	Br 28	
	34-1	NW	NW		--	1900	527	--	Css	P	587	So 41	MDC log

Table 2.--Records of wells and test holes in Chippewa County.--continued

Well designation T.R.	sec.-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
45N 2E	34-2	SW	SW	P. H. Kildal	Douglas Holzem	1955	72	6	Ols-ss	D	596	--	Water reported good
	34-3	SW	SW	E. S. Hammarsten	do.	--	91	6	Ols	D	612	--	Bedrock at 60 ft.; Water reported good
	36-1	NE	SE	Mrs. Harold Somes	--	--	--	1½	Qgd	D	620	So 54	
	36-2	NE	SE	Harold Somes	Douglas Holzem	--	290	6	Css	D	620	--	Bedrock at 77 ft.
45N 3E	31-1	SW	NW	James Lawrence	--	1934	75	--	--	D	625	So 48	
44N 6W	22-1	NE	SE	Birch Lodge	--	1937	90	1½	Qgd	P	--	Tk 7	
	23-1	NE	SW	Soo Line R.R.	--	--	30	4	--	I	--	Tk 15	
	23-2	NW	SE	Trout Lake High School	--	1943	37	2	--	P	--	Tk 1	
44N 5W	2-1	SE	SW	U. S. Forest Service	--	1937	269	5	Qgd	P	825	Tk 3	
	12-1	NW	NE	do.	--	1940	25	5	--	P	820	Tk 2	
	30-1	--	SE	Albert Mamph	--	--	18	6	--	-	--	--	Abandoned
44N 4W	21-1	SE	SE	Sherrand, Lodge, and Berry Lumber Camp	--	--	90	--	Qgd	I	--	Tk 17	
	25-1	NE	NE	I. Teets	--	--	206	--	Ols	D	710	Tk 18	Flows, Bedrock at 180
44N 3W	1-1	SW	SW	J. Derocia	Harry Yirs	1916	391	2	Qgd	-	672	--	Flows
	1-2	SW	SW	O. Braden	--	--	400	--	Qgd	D	670	Ry 48	Flows
	1-3	NW	SE	J. Riley	Harry Yirs	--	300	2	Qgd	-	680	--	Flows
	2-1	SW	SW	David Martin	do.	--	185	2	Qgd	D	686	--	Flows; Water reported good
	5-1	SW	NW	--	Frank Viilo	--	105	--	--	-	695	Ry 143	Bedrock at 105 ft.; No water
	5-2	SE	SW	Milo Lovelace	--	--	94	2	Qgd	-	695	--	Abandoned
	5-3	SE	SE	Fay Thomas	--	--	165	2	Qgd	-	693	Ry 47	Water reported good
	9-1	SE	NE	Carl Govan	Jas. Somerville	1901	145	3	--	-	685	Ry 73	Flows
	10-1	SW	SW	School	Harry Yirs	--	150	2	--	-	685	Ry 12	Abandoned
	10-2	SW	SE	Clayton Hanna	Jack Meehan	--	165	2	Qgd	D	685	--	Flows; Water reported good
	10-3	SE	SE	Hugh Loughhead	Jas. Somerville	1896	165	2	--	-	685	Ry 80	Flows
	10-4	SE	SE	Bob Hanna	Harry Yirs	1914	180	2	--	D	680	--	Flows; Water reported good
	11-1	NW	NW	Hazel DePater	do.	--	164	2	Qgd	D	685	--	Flows; Water reported good
	11-2	SW	NW	T. B. Mackie	do.	1915	189	2	Qgd	S	685	--	Flows
	11-3	SW	SW	Mrs. Josephine Porier	Jas. Somerville	1897	167	3	--	-	686	Ry 79	Flows
	11-4	SW	SW	Fred Poirer	Judson Daley	1914	180	2	--	D	682	--	Flows; Water reported good
	11-5	SW	SE	C. Forget	Harry Yirs	--	162	2	Qgd	S	683	--	Flows
	11-6	SE	SW	Turcotte	--	1902	160	3	--	-	678	Ry 28	Flows
	11-7	--	NW	T. B. Mackie	--	--	160	--	--	-	688	Ry 77	
	11-8	--	SE	A. LeGault	--	--	160	--	--	-	688	Ry 76	
	12-1	NE	NE	J. Germain	George Lawler	--	403	--	Qgd	-	672	Ry 81	
	12-2	NW	SW	J. Goodwin	--	--	--	1½	Qgd	-	683	--	Well abandoned
	15-1	NW	NE	Eugene Barril	Jas. Somerville	1899	153	3	--	-	685	Ry 74	
	15-2	SW	NW	J. G. Joyal	do.	1904	158	3	Qgd	-	675	Ry 75	
	16-1	--	SW	Herman Fuerstnau	Judson Daley	1901	116	2	--	D	690	Ry 53	
	16-2	NW	NW	Kermit Cartwright	Ulric Mayer	1948	120	2	--	-	690	Ry 141	Flows
	16-3	NW	SE	T. Holland	Jas. Somerville	1901	115	3	--	-	680	Ry 90	
	16-4	SE	NE	--	--	--	--	4	--	-	680	Ry 115	Flows
	16-5	NW	NW	J. B. Wilson	--	1900	135	2	--	-	690	Ry 70	
	17-1	SE	NW	R. G. Trimble	Jas. Sommerville	1900	130	3	--	D	690	Ry 69	Flows
	17-2	SE	NE	C. Everett	Judson Daley	1901	104	2	--	D	685	Ry 54	Flows
	17-3	SW	NE	Thomas Askwith	George Lawler	1904	138	3	Qgd	D	690	Ry 68	Flows
	17-4	NW	SW	Rudyard School	--	1914	165	2	--	-	692	Ry 7	Flows
	18-1	NE	SW	Fred Dowd	Ulric Mayer	1948	144	2	Qgd	D	693	Ry 140	Flows
	18-2	NW	SE	T. Anderson	Jas. Somerville	1900	110	1½	Qgd	-	690	Ry 66	Flows
	18-3	NW	SE	Armstrong Mill	do.	1903	110	3	Qgd	D	690	Ry 67	Flows
	20-1	--	NE	W. G. Elkins	Judson Daley	1910	134	--	Qgd	D	685	--	Flows
	21-1	SE	NE	P. Savoie	--	1903	113	2	Qgd	-	685	Ry 89	Flows
	22-1	NE	NE	E. Davidson	Jas. Somerville	1898	147	3	Qgd	D	680	Ry 82	Flows
	22-2	SW	NW	Robert Cartright	do.	1902	132	2	--	-	685	Ry 88	Flows
	22-3	NW	SW	H. McCraighton	--	1900	--	2	--	-	685	Ry 87	Flows
	25-1	NW	NW	--	Jack Meehan	--	180	4	Qgd	-	678	Ry 139	Flows; Bedrock at 180 ft.
	27-1	--	NW	Mayer	--	--	182	--	Qgd	-	710	Ry 20	
	27-2	SW	SW	Chubb Creek School	Harry Yirs	--	170	2	Qgd	-	700	Ry 8	Flows
	28-1	--	--	Dersher	Judson Daley	1901	114	2	--	D	695	Ry 52	Flows
	34-1	SW	NW	L. Hillock	Ulric Mayer	--	--	4	Qgd	D	694	--	Flows; Water reported good
	35-1	--	NE	Albert Douglass	George Lawler	1904	188	2	Qgd	-	670	Ry 112	Flows
	36-1	NE	SE	S. N. Peffers	do.	1904	186	2	Qgd	-	650	Ry 113	Flows
44N 2W	3-1	NW	SW	Glastader	--	--	100	3	Qgd	D	693	Ry 97	Abandoned
	3-2	SW	SE	Albert Housin	George Lawler	1904	151	2	--	D	680	Ry 94	Flows
	4-1	--	SW	T. Micheau	George Huntley	1900	32	3	--	-	680	Ry 101	Flows
	4-2	NW	NE	G. Dolman	G. Dolman	1905	72	2	--	D	700	Ry 64	Flows

Table 2.--Records of wells and test holes in Chippewa County.--continued

Well designation T.R.sec.No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
44N 2W 4-3	NW	NW	John Bergman	G. Dolman	1905	28	--	--	D	715	Ry 65	
4-4	NW	NW	John Sutton	Jack Meehan	--	54	4	--	-	715	Ry 137	Bedrock at 45 ft.
4-5	SW	SE	Bolman	George Lawler	1904	82	2	Qgd	D	693	Ry 98	Flows
5-1	--	--	S. Kendrick	Jas. Somerville	1896	100	2	--	-	690	Ry 105	Flows
5-2	NE	NW	Henry Cottle	Henry Cottle	1895	84	--	Qgd	-	695	Ry 59	Flowed; destroyed
5-3	NW	NW	do.	do.	1901	125	4½	Qgd	D	697	Ry 61	Flows
5-4	NW	NW	do.	do.	--	233	--	Qgd	-	700	Ry 60	Flowed; destroyed
5-5	NW	SW	County Shed	--	--	240	--	Qgd	P	690	Ry 32	
5-6	SW	SW	H. H. Wyatt	Jas. Somerville	1903	100	3	--	D	700	Ry 63	Flows
5-7	SE	SW	--	--	--	--	--	--	-	692	Ry 4	Flows
5-8	SE	SE	George Huntley	George Huntley	1897	96	3	Qgd	-	680	Ry 103	Flowed; abandoned
6-1	NE	NE	Benjamin Weiring	George Lawler	1904	190	2	Qgd	-	695	Ry 145	Flows
6-2	--	SE	Rudyard Twp.	--	--	300	--	Qgd	P	685	Ry 5	Flows
6-3	--	SE	E. Bonner	George Lawler	1904	268	2	--	D	685	Ry 62	Flows
6-4	SW	SE	Elk Hotel	Harry Yirs	--	280	--	--	P	685	Ry 3	Flows
6-5	SW	SE	Fountain House	Judson Daley	1903	278	2	Qgd	P	682	Ry 119	Flows
6-6	SW	SE	J. Anderson	Jas. Somerville	1904	285	3	Qgd	D	682	Ry 121	Flows
6-7	SW	SE	Mrs. Davidson	Judson Daley	1903	278	2	Qgd	-	685	Ry 118	Flows
7-1	NE	NE	Z. O'Conn r	Harry Yirs	1938	252	2	Qgd	P	685	Ry 33	Flows
7-2	NE	NE	do.	Douglas Holzem	--	238	6	Qgd	P	685	--	Flows
7-3	NE	NE	do.	Ulric Mayer	--	506	4	Ols	P	685	--	Flowed; "Sulfur water"; Abandoned
7-4	NE	NE	Rudyard School	--	1940	165	3	Qgd	P	685	Ry 11	Flows
7-5	NE	NE	do.	Harry Yirs	1924	315	2	Qgd	-	685	Ry 10	Flows
7-6	SE	NE	Peter Royer	George Lawler	1905	270	--	--	-	685	Ry 84	
7-7	NE	NW	Chippewa Wood Products	Harry Yirs	1940	380	--	Qgd	I	680	Ry 2	Flows
7-8	NW	SW	J. W. Davidson	do.	1914	348	2	Qgd	S	672	--	Flows
8-1	NE	NE	H. Johnson	George Huntley	1896	98	3	--	-	680	Ry 104	Flows
8-2	NW	NE	G. W. Kelly	Judson Daley	--	113	3	--	-	680	Ry 106	Flows
8-3	NW	NW	C. Beacom	--	--	185	--	Qgd	D	685	Ry 35	
8-4	NW	NW	do.	Harry Yirs	--	500	4	Oss	D	685	Ry 136	Flows
8-5	NW	NW	do.	do.	--	240	--	--	-	685	Ry 135	Flows
8-6	NW	NW	do.	do.	1917	425	--	--	-	685	--	Flowed; abandoned
8-7	SW	SW	Mattson	G. W. Jetter	1951	777	--	€ss	-	685	--	Flowed; MDC log 16324; "Sulfur water"
8-8	--	--	Naeme	Jas. Somerville	1898	98	3	--	-	687	Ry 100	Flows
9-1	NE	NE	Andrew Habella	Judson Daley	1903	108	2	Qgd	D	690	Ry 51	Flows
9-2	NW	NE	Nass	George Lawler	1904	104	2	--	-	693	Ry 99	
9-3	NW	NW	A. Pitsen	George Huntley	1898	92	5	Qgd	-	695	Ry 102	
9-4	SE	SW	Fred Jacobsen	do.	1901	113	2	--	-	685	Ry 91	
10-1	--	NE	Rev. G. A. Smith	Judson Daley	1903	171	2	Qgd	D	687	Ry 50	Flows
10-2	SW	SW	Sam Girvin	--	--	100	3	--	-	686	Ry 93	
15-1	NW	NE	--	--	--	50+	2	Qgd	-	685	--	Abandoned
16-1	--	NE	A. Wice	Nordhoff	1899	88	3	--	-	685	Ry 92	
16-2	SE	SW	--	--	--	110	--	Qgd	D	677	Ry 37	
17-1	SE	NE	--	-- ---	--	6	36	Qgd	-	682	--	Abandoned
17-2	NW	SW	Joe Desrocher	George Lawler	1905	216	2	Qgd	-	675	Ry 85	Flows
17-3	SW	SW	John Meeham	--	--	216	--	Qgd	D	675	Ry 27	
17-4	SW	SW	David Boucher	David Boucher	1898	220	3	Qgd	-	685	Ry 86	
18-1	NE	NE	Cheese Coop Factory	Ulric Mayer	--	268	4	Ols	I	680	--	Flows: Bedrock at 200 ft.
20-1	SE	NE	Edward Belcher	--	--	35	2	--	D	673	Ry 118	
21-1	SW	NW	Toivo Salo	--	--	--	3	--	D	674	- --	
21-2	SE	SE	L. R. Adamson	L. E. Leonard	--	147	48-3	Qgd	D	670	Ry 108	
22-1	--	SE	D. Perry	do.	--	67	--	--	D	670	Ry 107	
23-1	SW	SW	--	--	--	--	2	Qgd	-	673	--	Abandoned
25-1	NW	NW	J. Wallis	--	--	110	3	Qgd	D	661	--	Bedrock at 110 ft.
26-1	NW	NE	George Potts	L. E. Leonard	--	120	--	--	D	662	Ry 110	
27-1	NW	NW	Malin	--	--	200	--	Qgd	D	668	Ry 26	
28-1	NW	NW	Mike Knanf	Shelber-Leonard	--	144	--	--	D	670	Ry 109	
29-1	NE	NW	Finn Church	Jack Meehan	--	200	--	Qgd	-	670	Ry 138	Bedrock at 200 ft.
30-1	NW	NE	Frank Villo	Frank Villo	--	285	--	Qgd	-	660	Ry 142	
31-1	NW	NE	A. Aho	--	--	230	--	Qgd	-	662	Ry 19	Flows
31-2	SW	NE	S. McDonald	George Lawler	1904	208	2	--	-	650	Ry 111	Flows
31-3	NW	NW	Alvie Peffers	Harry Yirs	1926	208	2	Qgd	D	662	--	Flows
31-4	SW	NW	Ervin Aho	Frank Villo	1947	190	2	Qgd	D	660	--	Flows
31-5	SW	NW	Peter Stevenson	George Lawler	1904	173	2	Qgd	-	660	Ry 114	Flows
33-1	NW	NW	K. Oja	--	--	208	2	Qgd	D	655	--	Water reported good
33-2	NW	SW	--	--	--	205	--	Qgd	-	655	Ry 21	
44N 1W 10-1	--	SE	Philip Kibble	--	--	5	--	Qgd	D	720	Pf 25	
11-1	SE	SW	Albert Kibble	Albert Kibble	--	14	6	Qgd	D	700	--	Water reported good
15-1	NE	NW	R. A. Wilben	W. P. Roe	--	135+	--	Qgd	D	700	Pf 76	
20-1	SW	SW	Gordon Kemp	--	--	--	2	Qgd	-	680	--	Abandoned
25-1	NE	NW	Russel Allen	--	--	29	2	--	D	640	Pf 40	Flows
25-2	NE	SE	Nelson Issard	W. P. Roe	--	91	2	Qgd	D	624	--	
25-3	SE	SE	Charles Issard	W. P. Roe	--	132	2	Odol	D	625	--	Bedrock at 130 ft.
26-1	NW	NE	Alex Anderson	--	1923	16	4	Qgd	D	645	Pf 51	
26-2	NW	NW	George and Gordon Kemp	--	--	65	54	Qgd	D	650	Pf 45	
26-3	NW	SW	L. J. Hancock	--	--	21	48	Qgd	D	647	--	

Well designation T.R.	sec.-No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diam- eter (in.)	Aquifer	Use	Alti- tude (msl)	Former USGS No.	Remarks
44N 1W	30-1	NW	SW	John Dunbar	Judson Daley	1905	82	2	Qgd	D	664	Pf 86	
	31-1	SE	NE	Kenneth Bawks	--	--	--	2	Qgd	D	662	--	
	32-1	SE	SW	Fred Wallis, Jr.	--	1908	100	3	Qgd	D	653	Pf 53	
	32-2	SW	SE	James Cottle	--	--	24	--	Qgd	D	648	Pf 23	
	32-3	SW	SE	Carl Cottle	--	1913	109	--	--	D	648	Pf 55	
44N 1E	2-1	NW	NW	Leo Hedrington, Jr.	Ulric Mayer	1952	109	2	Qgd	D	611	--	Water reported soft
	2-2	NW	NW	Leo Hedrington, Sr.	John Melcher	--	120	2	--	D	611	--	Water reported good
	2-3	SW	SW	--	--	--	100	--	Qgd	-	609	Pf 104	Bedrock at 100+ ft.?
	10-1	NE	NE	Mills Camp	Archie Huff	1955	103	2	Qgd	D	598	--	Equipped with screen.
	10-2	NW	NE	F. Haefner	do.	1955	126	2	Qgd	D	602	--	Water reported good
	10-3	SW	SW	Art Libby	Ulric Mayer	1949	102	4	Qgd	-	600	Pf 99	
	10-4	NW	NE	Kelden School	--	--	200	2	--	D	600	Pf 3	
	10-5	SW	SE	Ray Hewitt	Ulric Mayer	1949	140	2	Qgd	D	600	Pf 100	
	11-1	NW	SE	--	--	--	--	2	Qgd	-	585	--	Flows
	14-1	SW	SW	State of Michigan	--	1935	332	6	Oss	P	590	Pf 7	Flows
	14-3	SE	SW	do.	Richard Kiney	1933	187	4	Qgd	-	590	Pf 5	
	15-1	NE	NW	A. L. Patin	Ulric Mayer	--	96	2	Qgd	D	603	--	Water reported good
	15-2	NW	NW	Vic Fortin	do.	1949	115	4	Qgd	D	600	Pf 31	
	18-1	NW	SW	G. H. Raynard	W. P. Roe	1955	80	2	--	D	667	--	
	19-1	NW	NW	Robert Roe, Jr.	do.	--	--	2	--	D	640	Pf 42	
	19-2	SW	NW	William Roe	do.	--	118	--	--	D	635	Pf 77	Flows
	19-3	SW	SW	James Parkers	do.	--	60	--	Qgd	-	620	Pf 96	Flows
	20-1	SE	NE	May Brindley	Ulric Mayer	1949	290	4	Oss	-	615	Pf 101	
	21-1	SE	NW	--	--	--	164	--	Qgd	-	615	Pf 105	
	21-2	SW	SW	Sterlingville School	--	--	60	2	--	-	625	Pf 4	
	22-1	SW	SE	Herb Nixon	--	--	20	36	Qgd	S	610	--	
	27-1	SE	SE	--	--	--	7.5	36	Qgd	-	680	--	
	28-2	NW	NW	James Hill	--	--	125	3	Qgd	D	635	Pf 21	
	28-3	SW	SW	Frank Pennington	--	--	85	2	Qgd	D	628	Pf 52	
	28-4	SE	SW	Roland Hill	--	--	42	18	--	D	640	Pf 43	
	28-5	SE	SW	R. Hill	Archie Huff	1954	67	2	Qgd	D	645	--	Water reported good
	28-6	NE	SE	Warren Hill	do.	1955	60	2	Qgd	D	660	--	Water reported good
	31-1	NW	SW	Clifford Harrison	--	--	80	48	Qgd	D	620	Pf 38	
	31-2	SW	SW	Pickford Creamery	Jack Meehan	1948	111	6	Qgd	I	605	Pf 95	Flows; Bedrock at 111 ft.
	31-3	SW	SW	do.	Jas. Somerville	1900	67	3	Qgd	I	605	Pf 89	Flows
	31-4	SW	SW	Fred Taylor	--	--	89	2	Qgd	D	620	Pf 68	Flows
	31-5	SW	SW	Harold Mortenson	--	1920	80	2	--	D	615	Pf 61	
	31-6	SW	SW	M. H. Nixon	--	--	81	2	Qgd	D	615	Pf 57	
	31-7	SW	SW	J. McDonald	--	--	87	2	Qgd	D	620	Pf 67	Flows
	31-8	SW	SW	Joseph Barton	Judson Daley	1902	119	2	Qgd	D	620	Pf 69	
	31-9	SW	SW	Fred Green	--	1905	--	--	Qgd	D	620	Pf 32	Flows
	31-10	SW	SW	G. and A. Taylor	--	--	78	--	Qgd	D	620	Pf 17	Flows; MDC log
	31-11	SW	SW	O. S. Roe	--	1899	68	2	Qgd	D	612	Pf 16	Flows
	31-12	SW	SW	F. H. Taylor	--	--	87	2	Qgd	D	600	Pf 15	Flows
	31-13	SW	SW	S. Crawford	Judson Daley	1902	87	2	Qgd	D	610	Pf 13	Flows
	31-14	SW	SW	David Stevens	--	--	95	2	Qgd	D	615	Pf 20	Flows
	31-15	SW	SW	P. Aldridge	Judson Daley	1905	127	2	Qgd	D	620	Pf 26	
	31-18	SE	SE	H. I. Best	do.	1904	91	2	Qgd	D	630	Pf 10	
	31-19	SW	SW	Dr. David Webster	Jas. Somerville	1899	128	3	Qgd	D	615	Pf 18	Flows
	31-20	NW	SW	T. E. Kirkbride	Judson Daley	1903	105	2	Qgd	D	625	Pf 12	
	31-21	SE	SW	Pickford Well	--	1907	1,500	10-8	Css	P	610	Pf 1	Flows; MDC log
	33-1	NE	NW	Calvin Warren	Archie Huff	1955	140	2	Ols	-	648	--	Bedrock at 90 ft.
	33-2	NW	SW	Charles Pennington	Judson Daley	--	92	2	Qgd	D	627	Pf 22	
44N 2E	4-1	NW	NE	Clyde Conely	--	--	43	4	Qgd	P	585	Br 29	Flows; Water reported good
	6-1	SW	NW	Les Fowler	John Melcher	1935	82	2	--	D	592	--	Flows
	6-2	SW	SE	L. Allard	do.	1932	80	2	--	D	582	--	Flows; Water reported good
	6-3	SE	SE	M. McCondra	do.	1930	120	2	--	D	582	--	Flows
	27-1	SE	SE	--	Stickland	--	200	6	Qgd	-	585	Rb 9	Drilled 200 ft. in cl[illegible] or shale; dry
	31-1	NE	SE	Munuscong School	--	--	4	48	--	P	587	Rb 6	
	31-2	NE	SW	R. Froman	W. P. Roe	1955	51	3	--	D	590	--	Water reported good
	31-3	NW	SE	Harold Pasco	do.	1952	51	3	--	D	590	--	
43N 1E	1-1	SW	SW	A. Crites	--	--	--	2	Qgd	D	689	--	
	6-1	NW	NW	Pickford School	Judson Daley	1902	122	2	Qgd	P	620	Pf 14	
	6-2	NW	NW	J. Robinson	do.	1905	129	2	Qgd	D	615	Pf 93	
	6-3	NW	NW	Dr. John Cameron	do.	1902	128	2	Qgd	D	615	Pf 92	Flows
	6-4	NW	NW	Grand Central Hotel	Jas. Somerville	1895	128	4	Qgd	P	615	Pf 90	Flows
	6-5	NW	NW	John Crawford	Judson Daley	1904	128	2	Qgd	D	615	Pf 87	Flows

Table 2.--Records of wells and test holes in Chippewa County.--continued

Well designation T.R.	sec.No.	Location in sec. ¼	¼	Owner	Driller	Year drilled	Depth (ft.)	Diameter (in.)	Aquifer	Use	Altitude (msl)	Former USGS No.	Remarks
43N 1E	6-6	NW	NW	George Wilson	Judson Daley	1903	131	2	Qgd	D	615	Pf 34	Flows
	6-7	NW	NW	John Stanley	Isaac McKee	1895	126	4	--	P	615	Pf 19	Flows
	6-8	NW	NW	Pickford Creamery	Anderson	--	750	8	--	I	620	Pf 65	Flowed, Bedrock at 135 ft. Abandoned.
	6-9	NW	NW	Pickford Schools	--	1936	100	3	--	P	610	Pf 64	
	6-10	NW	NW	Ernest Nixon	--	1947	100	2	Qgd	D	605	Pf 59	Flows
	6-11	NW	NW	Pickford Creamery	W. P. Roe	--	135	3	Qgd	I	615	Pf 66	
	6-12	NW	NW	Pickford High School	--	--	125	3	--	P	610	Pf 63	
	6-13	NW	NW	E. R. Sweeney	--	--	143	2	Qgd	D	615	Pf 54	
	6-15	NE	NE	John Henderson	Judson Daley	1905	92	2	Qgd	-	620	Pf 94	
	6-16	NW	NW	J. O'Niel	do.	1901	98	2	Qgd	D	615	Pf 2	Flows
	6-17	--	--	William Bacon	do.	1903	86	2	Qgd	D	615	Pf 11	Flows
	6-18	NW	NW	W. A. Roe	do.	1905	128	2	Qgd	D	615	Pf 91	
	6-20	SE	SE	James Clagg	do.	1904	120	2	Qgd	D	625		
	7-4	SW	SW	W. P. McDonald	Judson Daley	1903	151	2	Qgd	D	612	Pf 9	Flows
	7-5	SW	SW	do.	--	--	162	2	Qgd	D	612	--	
	8-1	SE	NE	George Portice	--	1913	103	3	Qgd	D	620	Pf 58	
	8-2	SE	NE	Merrill Hopkins	--	--	97	48-2	Qgd	D	620	--	
	8-3	NW	SW	Oliver Hintz	Archie Huff	--	145	2	Qgd	S	620	--	Bedrock at 145 ft.
	9-1	NE	NE	William Ames	--	--	150	2	Qgd	D	630	Pf 56	Flows
	10-1	SE	SE	--	--	--	10	48	Qgd	S	632	--	Water reported clear
	11-1	SE	NE	R. and A. Hart	--	--	--	2	--	-	690	--	
	13-1	SW	SW	Mrs. Ester McCord	--	1918	172	3	--	D	630	Pf 36	
	15-1	SW	SW	Mrs. William Storey	Archie Huff	1955	150	2	Qgd	D	625	--	Flows
	24-1	SW	SW	Russel Sims	W. P. Roe	1952	21	3	Sls	D	--	--	Water reported good
	24-2	NE	SE	W. J. Crawford	--	--	81	2½	--	D	--	Pf 70	
	35-1	--	NE	Richard Hanna	--	--	70	--	--	D	--	Pf 30	
	36-1	--	SE	James Duncan	James Duncan	--	60	--	Sls	D	700	Pf 29	
43N 2E	30-1	--	SW	R. G. Crawford	--	1923	139	2½	--	-	--	Rb 8	
	30-2	SW	SW	Stalwart School	--	--	90	2	--	-	--	Rb 3	
	30-3	SW	SW	do.	--	1923	50	--	--	-	--	Rb 4	
	31-1	NE	NE	E. Stec	Glass	--	93	6	Qgd	D	--	--	Flows
	31-2	SW	NW	George Sims	Walter Litzner	--	--	4	--	D	--	--	
	32-1	SW	SE	John Crisp	John Crisp	--	12	36	Qgd	D	--	--	Flowed
43N 3E	5-1	SW	SW	Boulder Point Cottages	W. P. Roe	--	70	4	--	-	588	--	
	16-1	SE	SE	M. Zwolinski	Archie Huff	--	45	2	Qgd	P	585	--	Flows
	18-1	NW	NE	Zaber School	--	1931	90	2	--	-	620	Rb 1	
	21-1	NE	NE	First Point Cabins	Archie Huff	--	120	2	Sls	P	587	--	Flows; Bedrock at 120 ft.
42N 2E	6-1	NW	NW	E. T. Johnson	--	--	102	4	--	-	--	Rb 7	
	6-2	NE	NE	Q. Bosley	Walter Litzner	--	192	4	--	-	--	--	
	21-1	NE	NW	Goetzville School	--	--	--	2	--	-	--	Rb 2	
42N 3E	17-1	SE	NW	Thomas Frankovich	T. Frankovich	1955	23	2	Qgd	S	--	--	
	21-1	SW	SE	L. Zwolinski	J. Kamen	--	48	2	Qgd	D	--	--	Water reported good
	21-2	SW	SE	do.	L. Zwolinski	--	80	2	Qgd	S	--	--	
	25-1	SW	NE	Smith's Cottages	Dagenoff	--	21	5	--	P	--	--	
	36-1	SE	SE	Hart Periard	--	--	38	6	Sls	P	--	--	Bedrock at 36 ft.
	36-2	SE	SE	W. W. Spears	--	1938	54	3	Qgd	-	--	De 1	
42N 4E	21-1	SW	NE	Dr. Holtzmiller	Walter Litzner	--	80	6	Sls	-	590	--	Flows
	21-2	SW	NE	Frank Holtzmiller	do.	--	80	6	Sdol	D	590	--	Flows
	21-3	NW	SE	Lawrence DuVall	Glass	--	80	6	Sls	-	590	--	Flows
	22-1	SW	SW	Spring Bay Dock Co.	Archie Huff	--	100	3	Sls	I	590	--	Bedrock at 33 ft.
	35-1	--	SW	DeTour High School	--	--	160	3	Sls	P	620	--	
	35-2	--	SW	DeTour Dock Co.	--	--	100	4	--	I	590	--	
41N 3E	1-1	NE	NE	Ingersol	Archie Huff	--	60	2	Sls	P	--	--	
41N 4E	3-1	SE	NE	Mich. Dept. of Conserv.	Walter Litzner	1952	88	4	Sss	-	600	--	
	10-1	SW	SE	U. S. Naval Station	--	--	119	--	--	-	590	--	
41N 6E	2-1	NW	SW	Miss Annie Hill	--	1940	215	2	--	-	--	Dr 2	
	2-2	NW	SW	Lincoln School	--	--	25	48	--	-	--	Dr 3	
41N 7E	17-1	NW	SW	Kreetan Co.	--	1944	1,050	6-5	Sls	I	673	--	MDC log 2264

Table 3.--Records of Michigan State Highway Department test borings in Chippewa County

Boring designation T.R.sec.No.		Location in sec. ¼	¼	Test hole No.	Depth (ft.)	Altitude (msl)	Former USGS No.1/	Remarks
47N 1E	6-1	SW	SE	1	25	614	So 1	Bedrock at 25 ft.
	6-2	SW	SE	1A	36	614	So 2	Bedrock at 29 ft.
	6-3	SW	SE	2	22	610	So 3	
	6-4	SW	SE	2A	40	614	So 4	Bedrock at 37 ft.
	6-5	SW	SE	3	33	614	So 5	Bedrock at 32 ft.
	6-6	NW	SE	3A	37	613	So 6	Bedrock at 25 ft.
	6-7	NW	SE	4A	41	613	So 7	Bedrock at 29 ft.
	6-8	NW	SE	6	31	613	So 8	Bedrock at 31 ft.
	19-3	NW	SE	-	91	700	So 46	
46N 6W	22-4	SW	NW	1	47	750	Cp 26	
	22-5	SW	NW	2	50	750	Cp 27	
	22-6	SW	NW	3	46	750	Cp 28	
	22-7	SW	NW	4	44	750	Cp 29	
46N 5W	29-6	SE	SW	-	32	820	Cp 25	
46N 3W	14-1	SW	NW	1	30	730	Sp 45	Finished in red clay
	14-2	SW	NW	2	38	730	Sp 46	do.
	15-1	SW	NE	1	25	750	Sp 43	Finished in fine sand
	15-2	SW	NE	2	26	750	Sp 44	do.
46N 2W	15-2	SE	SW	2	60	610±	Sp 50	
	15-3	SE	SW	3	75	610±	Sp 51	
	15-4	SE	SW	4	64	610±	Sp 52	Boulder at 22 ft.
	18-1	SE	SW	1	22	700±	Sp 47	
	18-2	SE	SW	2	26	700±	Sp 48	Boulder at 26 ft.
	22-2	NE	NW	1	75	610±	Sp 49	
	22-3	NE	NW	5	100	610±	Sp 53	
46N 1W	18-1	SE	SE	1	128	619	Df 12	Finished in soft red clay
	19-1	NE	NE	2	60	620	Df 13	do.
	36-2	SE	SE	1	53	632	Br 43	Bedrock at 53 ft.
	36-3	SE	SE	3	49	634	Br 45	Bedrock at 49 ft.
46N 1E	18-1	NE	SW	1	40	635	Br 39	Finished in red clay
	18-2	NW	SE	2	44	633	Br 40	do.
	18-3	NE	SW	3	40	632	Br 41	do.
	18-4	NW	SE	4	60	635	Br 42	do.
	31-5	SW	SW	2	54	630±	Br 44	Bedrock at 54 ft.
	31-6	SW	SW	4	48	630±	Br 46	Bedrock at 48 ft.

1/ See table 2.

Table 3.--Records of Michigan State Highway Department test borings in Chippewa County.--continued

Boring designation T.R.sec.No.		Location in sec. ¼	¼	Test hole No.	Depth (ft.)	Altitude (msl)	Former USGS No.1/	Remarks
44N 2W	24-1	SW	SE	1	64	625	--	Flows from gravel at 58 ft.
	24-2	SW	SE	3	61	625	--	Flows from cobbles at 61 ft.
	25-1	NW	NE	2	57	623	--	Flows from cobbles at 57 ft.
	25-2	NW	NE	4	61	627	--	Flows from cobbles at 61 ft.
	30-2	NW	NE	1	52	612	Ry 125	Finished in soft red clay
	30-3	NW	NE	2	82	613	Ry 126	do.
	30-4	NW	NE	3	44	616	Ry 127	do.
	30-5	NW	NE	4	45	617	Ry 128	do.
	30-6	NW	NE	5	64	611	Ry 129	do.
	30-7	NW	NE	6	58	612	Ry 130	do.
	30-8	NW	NE	7	55	632	Ry 131	do.
	30-9	NW	NE	8	40	628	Ry 132	do.
44N 1E	31-16	SW	SW	1	30	590	Ry 82	Finished in hard blue clay
	31-17	SW	SW	4	30	590	Ry 85	do.
43N 1E	6-18	NW	NW	2	59	590	Pf 83	do.
	6-19	NW	NW	3	58	590	Pf 84	do.
	7-1	NW	NW	2	60	605	Pf 72	Finished in sand and gravel
	7-2	NW	NW	4	44	600	Pf 73	do.
	7-3	NW	NW	6	64	605	Pf 74	do.
	17-1	NW	NE	1	24	600	Pf 78	Finished in red clay
	17-2	NW	NE	2	27	603	Pf 79	do.
	17-3	NW	NE	3	28	601	Pf 80	do.
	17-4	NW	NE	4	24	595	Pf 81	do.
41N 3E	8-1	NE	NE	1	36	--	De 2	Flow from gravel at 36 ft.
	8-2	NE	NE	2	30	--	De 3	Flow from gravel at 30 ft.
	8-3	NE	NE	3	36	--	De 4	Finished in sand and gravel
	8-4	NE	NE	4	26	--	De 5	do.

Table 4.--Selected logs of wells and test borings in Chippewa County, Mich.

Altitude: Estimated in feet above mean sea level.

	Thickness (feet)	Depth (feet)
49N 7W 28-1 Altitude 705		
Muck	15	15
Sand, water-bearing	1	16
49N 7W 31-1 Altitude 745		
Sand, red to buff, very fine to coarse, angular to well rounded, clean	60	60
Clay, brownish buff	50	110
Clay, reddish buff, sandy	25	135
Sand, fine to medium, very clayey	5	140
Clay, reddish brown, sandy, gravelly	5	145
Clay, reddish buff, sandy	10	155
Sand, very fine to fine, silty	10	165
Sand, very fine to medium, gravelly	5	170
Sandstone, yellow, medium to coarse, well rounded, large dark heavy metallic and non-metallic minerals conspicuous, water-bearing	7	177
Sandstone, yellow, fine to medium, some dark minerals, water-bearing	15	192
49N 7W 32-4 Altitude 629		
No record	25	25
Sand, very fine to medium, clean, poorly sorted, water-bearing	45	70
Sand, very fine to coarse, clean, poorly sorted, fine gravel, water bearing	26	96
Sand, very fine to coarse, clean, poorly sorted, water-bearing	4	100
49N 7W 32-6 Altitude 629		
Sand, dark-brown, fine to medium	15	15
Clay, dark gray, very sandy and silty	30	45
Sand, gray, very fine to medium, clean, water-bearing	29	74
Sand, fine to coarse, gravelly, water-bearing	26	100
49N 6W 3-2 Altitude 605		
No record	5	5
Clay, red, thin beds of sand	245	250
49N 6W 11-1 Altitude 608		
Sand	10	10
Hardpan	1	11
Sand, water-bearing	6	17
49N 6W 22-1 Altitude 625		
Sand and muck	4	4
Sand, yellow, packed	1.5	5.5
Sand	8.5	14
Sand, fine	4	18
Sand	3	21
Hardpan	0.5	21.5
49N 6W 27-2 Altitude 645		
Sand, yellow, fine	17	17
Hardpan	5	22
Sand, white, coarse	10	32
Sand, fine	60	92
Sand, yellow, water-bearing	9	101
48N 6W 14-1 Altitude 610		
Sand	17	17
Clay, blue	92	109
Sand and gravel	8	117
48N 6W 15-1 Altitude 605		
Silt, black	20	20
Sand, clay streaks	140	160
48N 6W 32-1 Altitude 655		
Hardpan	3	3
Sand	3	6
Clay	20	26
Sand, white	12	38
Rock	2	40
48N 6W 32-4 Altitude 685		
Sand, fine	20	20
Clay, red	16	36
Gravel, coarse	2	38
Rock, hard, water-bearing	2	40
47N 7W 11-1 Altitude 856		
Sand, white	290	290
Boulders, gravel	7	297
47N 6W 5-1 Altitude 710		
Sand	4	4
Clay	20	24
Sand, fine	6	30
Clay	1	31
Gravel and sand	8	39
Sand, water-bearing	5	44
47N 6W 18-1 Altitude 851		
Sand	20	20
Clay	12	32
Sand, fine	38	70
Gravel	16	86
47N 4W 24-1 Altitude 620		
Sand, water-bearing	31	31
47N 4W 28-2 Altitude 620		
Sand, brown, very fine to fine	20	20
Sand, buff, fine to coarse, gravelly	5	25
Sand, buff to brown, very fine to coarse	120	145
Sand, tan to buff, fine to coarse	35	180
47N 3W 10-1 Altitude 610		
Sand, fine, and gravel, water-bearing	128	128
Rock	--	128
47N 3W 12-1 Altitude 624		
Sand and gravel, clayey, water-bearing	66	66
47N 3W 15-1 Altitude 1,010		
Sand	365	365
Sandstone, water-bearing	5	370
47N 2W 29-1 Altitude 608		
Clay, sandy	70	70
Sand and gravel	8	78
Sand, fine, water-bearing	84	162
47N 2W 31-1 Altitude 620		
Sand	50	50
Sand, water-bearing	16	66
47N 2W 34-1 Altitude 609		
Sand	6	6
Clay	125	131
47N 2W 34-1 Continued		
Clay and sand	175	306
Hardpan	12	318
Rock, hard	1	319
Sandstone, soft, water-bearing	9	328
Rock, hard	--	328
47N 2W 34-7		
Sand	6	6
Clay, red	114	120
Sand, fine	20	140
Clay, blue	101	241
Sand, fine, and gravel, water-bearing	15	256
Hardpan "or rock"	6	262
47N 2W 35-2 Altitude 608		
Sand	7.5	7.5
Clay	2	9.5
Clay and gravel	1	10.5
Gravel	2.5	13
Sand and gravel	11.5	24.5
Sand, fine	1.5	26
Sand and gravel	5	31
Hardpan "or bedrock"	4	35
Sandstone, red, water-bearing	7	42
47N 1W 11-1 Altitude 640		
Sand and gravel	91	91
Sandstone, purple, hard	24	115
Sandstone, brick-red, soft	10	125
Sandstone, light buff, hard	10	135
Sandstone, purple, hard	50	185
Sandstone, buff, soft	10	195
Sandstone, brick-red and brown	50	245
Sandstone, white	20	265
Sandstone, purple, hard	60	325
Sandstone, brick-red	30	355
Sandstone, greenish-white	10	365
Sandstone, purple	60	425
No record	90	515
Sandstone, buff to brown, shaly	10	525
No record	60	585
Sandstone	160	745
Sandstone reported	253	998
47N 1W 23-1 Altitude 750		
Boulders and gravel	5	5
Sand, coarse	38	43
Gravel and boulders, water-bearing	112	155
Sandstone and interbedded red shale	613	768
Sandstone, tan, very fine, hard, shaly	7	775
Sandstone, red and brown, interbedded red and gray shale	63	828
Sandstone, white, fine, hard	10	838
Sandstone, hard, shaly	45	883
Sandstone, red	631	1,514
47N 1W 24-4 Altitude 715		
Clay and fine sand	107	107
Sandstone, red, and interbedded shale, water-bearing	23	130
47N 1W 32-2 Altitude 640		
Clay	70	70
Gravel and sand	60	130
Sandstone, water-bearing	60	190

Table 4.--Selected logs of wells and test borings in Chippewa County --continued

	Thickness (feet)	Depth (feet)
47N 1E 6-7 Altitude 613		
Sand	29.5	29.5
Rock, broken	7	36.5
Sandstone, soft, laminated	2	38.5
Rock, solid	3	41.5
47N 1E 11-1 Altitude 590		
Clay and boulders	50	50
Sandstone, water-bearing	2	52
47N 1E 19-1 Altitude 707		
Clay, red	50	50
Clay, sandy	15	65
Gravel, water-bearing	2	67
47N 1E 21-2 Altitude 624		
Clay, red	61	61
Gravel	3	64
No record	36	100
Bedrock	--	100
47N 1E 27-1 Altitude 620		
Clay	60	60
Gravel, water-bearing	15	75
47N 1E 28-2 Altitude 630		
No record	40	40
Sand at		40
Gravel	20	60
Sandstone, water-bearing	220	280
47N 1E 33-2 Altitude 685		
Clay, red	45	45
Sand and gravel	95	140
Sandstone, water-bearing	78	218
47N 1E 35-1 Altitude 620		
Sand	10	10
Gravel and boulders	33	43
Sand	5	48
Gravel and sand	4	52
Sandstone	31	83
46N 6W 3-1 Altitude 820		
Clay and sand	140	140
Gravel	3	143
46N 6W 22-3 Altitude 760		
Sand and hardpan	6	6
Clay, soft	40	46
Clay, hard, gritty	20	66
Gravel	20	86
Clay	5	91
Gravel	5	96
46N 6W 22-5 Altitude 750		
Topsoil, black, peaty	2	2
Sand, gray, fine	19	21
Sand, gray, fine, clayey	8	29
Clay, red	21	50
46N 6W 22-8 Altitude 775		
Sand	15	15
Clay	19	34
Gravel, water-bearing	1	35
46N 6W 22-10 Altitude 750		
Sand	4	4
Clay	30	34
Marl	10	44
Sand, water-bearing	8	52
46N 6W 34-1 Altitude 860		
Till, red	40	40
Sand	7	47
46N 6W 35-1 Altitude 950		
Sand	25	25
Clay, red	8	33
Clay and sand	47	80
Clay, red	10	90
Sand	28	118
46N 5W 29-6 Altitude 820		
Muck, black	3	3
Sand, fine	5	8
Gravel	0.3	8.3
Sand	23.7	32
46N 5W 30-1 Altitude 830		
Sand	7	7
Clay, red to gray	168	175
Hardpan, gravelly	10	185
Sand, fine	16	201
"Hard crust", water-bearing	2	203
46N 5W 30-2 Altitude 825		
Clay	185	185
Sand	35	220
Rock	--	220
46N 4W 2-1 Altitude 890		
Clay and sand	--	--
Clay and gravel	--	--
Sand	--	--
Clay, red, and fine sand	--	--
Sand, clean	--	--
46N 4W 20-1 Altitude 915		
Sand, water-bearing	58	58
46N 4W 28-1 Altitude 907		
Sand, yellow, clean	5	5
Sand, white, clean	25	30
Sand, coarse, clean	10	40
Sand, red, water-bearing	20	60
Sand, red, very fine, water-bearing	40	100
Sand, red, extremely fine, water-bearing	5	105
46N 3W 14-2 Altitude 730		
Peat	4	4
Sand, red, very fine	10	14
Clay, red, very soft	24	38
46N 3W 15-2 Altitude 750		
Topsoil, black	1	1
Sand, red, very fine	25	26
46N 3W 19-1 Altitude 840		
Sand	63	63
46N 3W 22-1 Altitude 700		
Clay	30	30
Sand, fine	20	50
Sand	5	55
46N 2W 1-2 Altitude 666		
Clay	28	28
Sand and gravel	2	30
46N 2W 3-1 Altitude 615		
Clay	186	186
Hardpan	4	190
Clay, sand, and gravel	10	200
46N 2W 4-1 Altitude 610		
Sand, yellow, medium	12	12
Clay, red	28	40
Clay, red, sandy	120	160
Sand, yellow-brown, fine to coarse	198	358
Sand, reddish buff, very fine, sharp	7	365
Sand, pink, medium	14	379
Sand, multicolored, fine to coarse, with quartz, feldspar, hornblende	13	392
46N 2W 4-2 Altitude 620		
Sand	25	25
Clay	310	335
Sand	80	415
46N 2W 4-5 Altitude 650		
Clay and fine sand	398	398
Sandstone, water-bearing	331	729
46N 2W 4-9 Altitude 610		
Sand, brown, pitted	6	6
Sandstone, red, pitted	24	30
Shale, light pink, sandy	270	300
46N 2W 5-1 Altitude 620		
Clay	234	234
Sand, dry	--	--
Sand, wet	--	--
Sand, dry	--	--
Clay	40	--
Sand, fine	--	410
46N 2W 5-2 Altitude 610		
Clay	100	100
Sand, fine	65	165
Gravel	1	166
46N 2W 5-4 Altitude 620		
Clay	100	100
Sand, fine	30	130
Sand	10	140
Bedrock	--	140
46N 2W 6-1 Altitude 620		
Sand, clay, and gravel	182	182
46N 2W 15-3 Altitude 610		
Water	9	9
Boulders	1	10
Logs	1	11
Clay, red, soft	64	75
46N 2W 16-2 Altitude 675		
Clay	60	60
Clay and hardpan	36	96
Bedrock or hardpan	6	102
46N 2W 16-4 Altitude 657		
Clay	97	97
Rock or hardpan		97

Table 4.--Selected logs of wells and test borings in Chippewa County --continued

	Thick-ness (feet)	Depth (feet)
46N 2W 17-1 Altitude 684		
Clay	70	70
Sand, fine	2	72
Rock	10	82
46N 2W 18-2 Altitude 700		
Clay loam, silty	4	4
Clay, red, soft	14	18
Sand, gray, fine, marly, gravelly	8	26
46N 2W 18-3 Altitude 700		
Clay	13	13
Boulders	17	30
Rock	9	39
6N 2W 20-2 Altitude 685		
Clay	61	61
Sand, fine	2	63
46N 2W 20-3 Altitude 690		
Clay and boulders	22	22
Rock	2	24
46N 2W 22-1 Altitude 630		
Clay	350	350
Sand, fine	50	400
Gravel	10	410
46N 2W 22-3 Altitude 610		
Clay, red, soft	100	100
46 2W 23-1 Altitude 640		
Clay, red	32	32
Clay and fine sand	228	260
Clay, blue	55	315
Rock ?	--	315
46N 2W 24-1 Altitude 657		
Clay and sand	111	111
Rock ?	--	111
46N 2W 25-1 Altitude 657		
Sand, water-bearing	125	125
46N 2W 28-1 Altitude 630		
Clay	250	250
Sand, water-bearing	52	302
46N 1W 1-1 Altitude 670		
Clay	105	105
Sand, fine	25	130
Rock	5	135
46N 1W 13-1 Altitude 650		
Clay	40	40
Hardpan	148	188
Rock	--	188
46N 1W 14-4 Altitude 660		
Gumbo clay, soft	65	65
Sand, fine, water-bearing	35	100
Sand	46	146
Gravel, water-bearing	--	146
46N 1W 18-1 Altitude 619		
Water	1.3	1.3
Clay, silty, peaty	1.7	3
Peat, silty, woody	8	11
Clay, red, silty, soft	117	128
46N 1W 19-1 Altitude 620		
Clay, red, soft	0.5	0.5
Peat, soft, silty, woody	6.5	7
Clay, red, silty, peaty	5	12
Clay, red, silty, soft	48	60
46N 1W 20-2 Altitude 650		
Clay	60	60
Sand, water-bearing	88	148
46N 1W 22-3 Altitude 690		
No record	40	40
Boulders at		40
Clay	20	60
Sand, water-bearing	10	70
46N 1W 32-3 Altitude 700		
Clay and gravel	35	35
Gravel, water-bearing	1	36
46N 1W 34-1 Altitude 705		
Clay, red	70	70
Limestone, blue, hard, water-bearing	5	75
46N 1W 36-2 Altitude 632		
Topsoil	1	1
Silt	3	4
Clay, red	36	40
Sand, fine	13	53
Rock	--	53
46N 1E 18-4 Altitude 635		
Clay loam	1	1
Clay, red, slippery	59	60
46N 1E 19-1 Altitude 640		
Clay, red	210	210
Gravel	1.5	211.5
46N 1E 25-1 Altitude 660		
Sand	9.5	9.5
Clay	70.5	80
Gravel	--	80
46N 1E 26-1 Altitude 640		
Sand	7	7
Clay	68	75
Gravel	3	78
46N 1E 31-5 Altitude 630		
Topsoil	3	3
Silt	6	9
Clay, red	26	35
Sand, fine	19	54
Rock	--	54
46N 1E 35-1 Altitude 670		
Boulders	55	55
Sand, water-bearing	61	116
46N 2E 4-1 Altitude 620		
Clay	334	334
Sand	50	384
45N 4W 6-1 Altitude 790		
Sand	28	28
45N 2W 16-1 Altitude 750		
Sand	150	150
45N 2W 20-1 Altitude 790		
Sand and gravel	125	125
45N 2W 20-3 Altitude 760		
Sand	100	100
45N 2W 24-1 Altitude 740		
Sand, dry	26	26
Sand, water-bearing	8	34
Gravel	0.5	34.5
Sand and clay	8.5	43
45N 2W 25-1 Altitude 790		
Sand and gravel, water-bearing	96	96
45N 2W 29-1 Altitude 708		
Clay	8	8
Boulders and fine sand, clayey, water-bearing	112	120
45N 2W 29-2 Altitude 711		
Clay	80	80
Sand and small boulders, water-bearing	52	132
45N 2W 31-2 Altitude 705		
Clay, red	85	85
Sand, fine	25	110
Gravel, water-bearing	8	118
45N 2W 32-3 Altitude 700		
Clay, red, hard to soft	80	80
Sand, fine	20	100
45N 2W 33-3 Altitude 695		
Clay, red	50	50
Sand, water-bearing	18	68
45N 2W 36-1 Altitude 710		
Sand	8	8
Clay	72	80
Marl and sand	24	104
45N 1W 28-2 Altitude 795		
Sand, water-bearing	82	82
45N 1W 29-1 Altitude 795		
Sand	40	40
Sand, bouldery	30	70
Sand, traces of hardpan	10	80
Sand, water-bearing	1	81
Gravel, water-bearing	1.5	82.5
Sand, fine	37.5	120
Gravel, water-bearing	20	140
Sand, fine	5	145
45N 1W 31-1 Altitude 790		
Sand	90	90
Sand and gravel	72	162
45N 1W 33-1 Altitude 795		
Sand and gravel, water-bearing	144	144
45N 1E 2-1 Altitude 620		
Sand and boulder	65	65
45N 1E 4-1 Altitude 663		
Clay, red, laminated, "pebble-free"	28	28
Gravel, water-bearing	2	30
45N 1E 13-2 Altitude 660		
Sand	8	8
Clay	138	146
Sand and gravel	0.5	146.5
45N 1E 18-1 Altitude 694		
Glacial drift	100	100
Dolomite, brown	56	156
Limestone	5	161
Dolomite	10	171
Limestone	10	181
Dolomite	10	191
Limestone	20	211
Dolomite	15	226
Sandstone, with shale, dolomite, and limestone	205	431
Sandstone	156	587
45N 1E 22-1 Altitude 650		
Rock, gray, soft	20	20
Rock, red	33	53
Rock, gray, hard	70	123
45N 2E 6-4 Altitude 595		
Sand	2	2
Clay	4	6
Sand, fine	54	60
Gravel	5	65

Table 4.--Selected logs of wells and test borings in Chippewa County.--continued

	Thickness (feet)	Depth (feet)
45N 2E 34-1 Altitude 587		
Clay, sand, and boulders	33	33
Limestone, hard	1	34
Limestone, soft, water-bearing	1	35
Limestone, hard to medium hard, shaly	107	142
Limestone, hard to medium hard	16	158
Limestone, blue, shaly	27	185
Shale	1	186
Limestone, hard	4	190
Shale (well cased to 198 ft.)	8	198
Limestone	2	200
Shale, thinly bedded	5	205
Limestone	9	214
Limestone, thinly bedded	9	223
Sandstone, white	10	233
Shale	2	235
Sandstone, white, water-bearing	149	384
Sandstone, light-red	33	417
Shale, black, sandy, and red conglomerate	89	506
Sandstone	21	527
45N 2E 36-2 Altitude 620		
Clay, sand, and gravel	77	77
Dolomite, gray	188	265
Shale, red, black, and gray	20	285
Sandstone, white, water-bearing	5	290
44N 5W 2-1 Altitude 825		
Sand	5	5
Clay, blue	130	135
Sand, fine	134	269
44N 4W 25-1 Altitude 710		
No record	180	180
Limestone, water-bearing	26	206
44N 3W 1-2 Altitude 670		
Clay	250	250
Sand and gravel, water-bearing	150	400
44N 3W 9-1 Altitude 685		
Clay, red	16	16
Gravel and clay	10	26
Clay, red	118	144
Gravel	1	145
44N 3W 10-1 Altitude 685		
Clay	125	125
44N 3W 15-2 Altitude 675		
Clay, red and blue	110	110
Gravel, water-bearing	1	111
Clay and sand, "alternating"		
Gravel	--	--
44N 3W 16-2 Altitude 690		
Clay	100	100
Sand	15	115
Gravel	5	120
44N 3W 18-2 Altitude 690		
Clay, red	100	100
Sand	10	110
44N 3W 20-1 Altitude 685		
Clay	100	100
Sand	25	125
Gravel, fine	9	134
44N 3W 27-1 Altitude 710		
Clay	150	150
Sand, water-bearing	10	160
Hardpan	22	182
44N 3W 35-1 Altitude 670		
Clay, red	150	150
Sand and gravel	38	188
44N 3W 36-1 Altitude 650		
Clay, red	180	180
Sand, water-bearing	6	186
44N 2W 5-2 Altitude 695		
Clay, red	60	60
Sand, fine	22	82
Gravel, clean, water-bearing	2	84
44N 2W 5-3 Altitude 697		
Clay, red, gravelly	90	90
Sand, blue	30	120
Gravel, water-bearing	5	125
44N 2W 5-8 Altitude 680		
Clay, red	74	74
Sand, blue, water-bearing	6	80
Gravel, water-bearing	20	100
44N 2W 6-1 Altitude 695		
Clay, red	140	140
Sand	50	190
44N 2W 6-5 Altitude 682		
Clay, red	204	204
Clay, black	20	224
Sand, gray, fine	53	277
Gravel	1	278
44N 2W 8-7 Altitude 685		
Clay, red	40	40
Gravel, water-bearing	20	60
Clay, gravel, and sand	120	180
Dolomite, water-bearing	85	265
Shale, black and gray	250	515
Dolomite and limestone	232	747
Sandstone, water-bearing	58	805
44N 2W 9-1 Altitude 690		
Clay, red	100	100
Gravel, water-bearing	8	108
Hardpan	--	--
44N 2W 17-4 Altitude 685		
Clay, red	175	175
Sand, blue, water-bearing	20	195
Sand, fine	25	220
44N 2W 21-2 Altitude 670		
Clay, red	130	130
Sand, black, water-bearing	15	145
Gravel, water-bearing	2	147
44N 2W 24-1 Altitude 625		
Clay, red, soft, laminated, silty	42	42
Clay, gray, soft, silty, interbedded silt	14	56
44N 2W 24-1 Continued		
Cobbles	0.5	56.5
Silt and very fine sand	1.5	58
Gravel, coarse, water-bearing	4	62
Sand, fine, water-bearing	2	64
44N 2W 25-2 Altitude 627		
Sand and clay loam	4.5	4.5
Sand, silt, and clay	4.5	9
Clay, red and gray	52	61
Cobbles, water flows at 61 ft.		
44N 2W 27-1 Altitude 668		
Clay and sand	200	200
44N 2W 30-3 Altitude 613		
Sand, fine	13.5	13.5
Clay, red, soft	69	82.5
44N 2W 31-1 Altitude 662		
Clay	140	140
Sand and boulders, water-bearing	90	230
44N 2W 33-2 Altitude 655		
Clay to sand to hardpan	205	205
44N 1W 15-1 Altitude 700		
Sand, fine to medium, water-bearing	125	125
Clay, gray	10	135
Sand, water-bearing	--	135+
44N 1E 10-3 Altitude 600		
Clay, red	100	100
Sand	2	102
Boulder	--	102
44N 1E 10-5 Altitude 600		
Clay	100	100
Sand, fine	30	130
Gravel, bouldery, water-bearing	10	140
44N 1E 14-1 Altitude 590		
Clay, gray and brown	15	15
Clay, brown, sandy, gravelly	192	207
Sand and gravel, clayey	3	210
Sand and clay	5	215
Sand, coarse, clayey	10	225
Clay, brown, sandy	5	230
Limestone, brown, shaly	5	235
Sandstone, brown, and brown limestone, water-bearing	20	255
Dolomite, gray, sandy	10	265
Sandstone, gray, and gray dolomite, interbedded	15	280
Dolomite, light-brown, sandy	5	285
44N 1E 14-3 Altitude 590		
Sand and clay, bouldery	26	26
Clay, red and blue, soft to hard, gravelly and bouldery	139	165
Clay, soft, and sand	2	167
Sand, compact, and clay, water-bearing	8	175
Sand and gravel, hard, no water	8	183
Sand and gravel, compact, water-bearing	4	187

Table 4.--Selected logs of wells and test borings in Chippewa County --continued

	Thickness (feet)	Depth (feet)
44N 1E 15-2 Altitude 600		
Clay, red	85	85
Sand, fine to coarse gravel, water-bearing	30	115
Boulders	--	115
44N 1E 20-1 Altitude 610		
No record	130	130
Gravel	10	140
Sand	35	175
Sandstone, water-bear ng	115	290
44N 1E 28-2 Altitude 635		
Sand, bluish-gray, clayey, water-bearing	125	125
44N 1E 28-6 Altitude 660		
Sand	7	7
Clay	43	50
Sand and gravel	10	60
44N 1E 31-18 Altitude 620		
Clay, red	73	73
Sand and gravel, water-bearing	18	91
44N 1E 31-21 Altitude 610		
Clay, red	119	119
Sand, water-bearing	13	132
Dolomite, hard, shaly layers near top	128	260
Shale, blue	215	475
Shale, black	50	525
Limestone, white, pyritic and cherty	275	800
Sandstone, red	700	1,500
44N 1E 33-2 Altitude 627		
No record	84	84
Gravel, water-bearing	8	92
43N 1E 6-4 Altitude 630		
Clay, red	80	80
"Slush"	34	114
Gravel, water-bearing	14	128
43N 1E 6-20 Altitude 620		
Clay	118	118
Gravel	2	120
43N 1E 7-3 Altitude 605		
Clay, red, soft, stony	3	3
Clay, red and blue, soft to firm, silty	40	43
Sand, fine to medium, and silt	4	47
Sand, gravel, and "stones", silty	17	64
43N 1E 7-4 Altitude 612		
Clay, red	100	100
Sand, black, fine, water-bearing	49	149
Gravel, water-bearing	2	151
43N 1E 15-1 Altitude 625		
Clay	85	85
Sand, fine	42	127
Clay and hardpan	8	135
Sand, medium to coarse	15	150
43N 1E 17-3 Altitude 601		
Topsoil	1	1
Clay, red	27	28
43N 1E 24-1		
Clay	18	18
Limestone, water-bearing	4	22
41N 3E 8-3		
Water	2	2
Sand, yellow and gray, silty to clayey	18	20
Clay, blue, soft, and silt	1	21
Sand, gray, fine, silty	9	30
Gravel, medium and fine, and sand laminated	6	36
41N 4E 3-1		
Sand, fine	10	10
Sand and boulders, water-bearing	17	27
Limestone, water-bearing	3	30
Sandstone and limestone	58	88
41N 7E 17-1 Altitude 673		
Soil and rock mantle	7	7
Dolomite	123	130
Dolomite, cherty	67	197
Dolomite, water-bearing	4	201
Dolomite, cherty	16	217
Dolomite	106	323
Limestone and interbedded dolomite	77	400
Dolomite	40	440
Shale, green, and dolomite	25	465
Shale, reddish-purple and green, gray dolomite, and gypsum	14	479
Dolomite	11	490
Shale, reddish-purple, dolomite, and selenite gypsum	5	495
Dolomite	34	529
Limestone	5	534
Dolomite	172	706
Limestone and dolomite	35	741
Dolomite and shale	9	750
Shale, gray	130	880
Dolomite, gray	85	965
Shale, dark	33	998
Limestone and dolomite	52	1,050

Table 5.--Summary of data from seismic study of the bedrock surface in Chippewa County (Adapted from U. S. Corps of Engineers, 1949.)

Location ¼	¼	sec.	T.	R.	Corps of Eng. line No.	Elevation in feet above mean sea level: Land surface	Bedrock	Bedrock below 1/
NE	NE	9	46N	2W	17	648	--	514
NW	SE	16	46N	2W	16	645	--	500
SE	SE	19	46N	2W	15	690	652	--
SW	NW	27	46N	2W	14	606	--	479
NW	NW	35	46N	1W	36	696	648	--
SW	SW	8	46N	1E	38	661	--	500
NW	NW	15	46N	1E	34	670	609	--
NE	NE	25	46N	1E	33	600	--	482
SW	SW	2	45N	2W	13	663	--	530
SE	SE	14	45N	2W	12	733	--	571
NW	NW	36	45N	2W	11	707	--	562
SE	NE	4	45N	1W	32	690	616	--
SW	SE	5	45N	1W	35	715	642	--
NW	NE	11	45N	1W	37	685	608	--
SE	SE	13	45N	1W	31	698	--	608
SE	SE	20	45N	1E	30	660	--	540
NE	NE	10	44N	2W	10	657	--	528
SE	SE	16	44N	2W	9	677	--	497
NW	NE	32	44N	2W	8	655	--	525
NE	NW	4	44N	1E	29	610	--	492
SE	NE	10	44N	1E	28	600	--	479

1/ Seismic data indicates glacial drift present at elevation listed. Depth to bedrock surface not known.

Table 6.--Records of water levels and artesian pressures in Chippewa County.--continued

Well designation T.R.sec.No.	Date	Water level meas. or rept.	+ or - lsd (ft.)	msl (ft.)
43N 3E 5-1	Nov. 1, 1955	rept.	- 17	--
42N 3E 17-1	Oct. 31, 1955	meas.	- 12.87	--
21-1	Oct. --, 1955	rept.	- 4	--
21-2	Oct. 31, 1955	rept.	- 9	--
25-1	do.	rept.	- 5	--
36-1	Nov. 1, 1955	rept.	0	--

Well designation T.R.sec.No.	Date	Water level meas. or rept.	+ or - lsd (ft.)	msl (ft.)
42N 4E 3-1	July 11, 1955	rept.	- 5	--
41N 3E 1-1	-- -- 1955	rept.	- 15	--
41N 4E 10-1	Aug. -- 1949	rept.	- 13	577

Table 7.--Chemical analyses of water samples in Chippewa County, Mich.

Aquifer: Css - sandstone of Cambrian age; Ols - limestone of Ordovician age; Oss - sandstone of Ordovician age; Qgd - glacial drift of Quaternary age.

Analyst: U. S. Geological Survey; M - Michigan Department of Health; A - Michigan Agricultural College (now Michigan State University); T - Michigan College of Mining and Technology.

Potassium: + indicates potassium (K) included in value listed under sodium.

Remarks: Temperatures given in degrees Fahrenheit; Al - aluminum.

Well Designation T.R.sec:No. or source	Aquifer sampled	Analyst	Date	Chemical constituents (parts per million)															Specific conductance (micromhos at 25° C.)	pH	Remarks
				Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total solids	Hardness as $CaCO_3$			
FRESH GROUND WATER																					
49N 7W 31-1	Qgd	U	11-11-54	14	.24	-	28	5.2	14	2.4	154	0	.8	1.3	.2	.4	147	94	232	8.2	Temp., 46.3; AL .2
49N 6W 27-1	Qgd	M	10- -49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	Iron present
27-2	Qgd	M	10- -49	-	6.0	-	-	-	-	-	-	-	-	-	-	-	-	135	-	-	Appearance - red
47N 5W 12-2	-	M	7-31-51	-	.5	-	-	-	-	-	-	-	-	4	-	-	-	50	-	-	
12-2	-	M	-	-	-	-	-	-	-	-	-	-	-	Tr.	-	-	-	40	-	-	
47N 2W 35-3	-	M	11- 3-53	-	.5	-	-	-	-	-	-	-	-	Tr.	-	-	-	116	-	7.5	Color - 70
47N 1W 14-3	Css	U	9-26-55	-	-	-	42	-	7.8	-	-	-	-	1.0	-	-	216	-	345	-	Pumped 26 hours
47N 1E 12-1	Css	U	10-11-55	-	-	-	20	-	58	-	-	-	-	46	-	-	237	-	410	-	Appearance - clear
21-1	Qgd	U	10- 3-55	-	-	-	40	-	14	-	-	-	-	1.0	-	-	204	-	324	-	Appearance - clear
22-1	Css	U	10- 3-55	-	-	-	69	-	105	-	-	-	-	180	-	-	538	-	968	-	Appearance - clear
26-2	-	M	-	-	2.4	-	-	-	-	-	-	-	-	-	-	-	-	180	-	-	
33-2	Css	U	9-28-55	-	-	-	31	-	92	-	-	-	-	64	-	-	359	-	626	-	Appearance - clear
46N 2W 4-1	Qgd	U	11-11-55	13	.04	.07	37	4.6	14	2.6	125	0	12	23	.4	-	163	111	290	8.2	Temp., 47.51 Appearance - clear
46N 1W 32-3	Qgd	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	105	-	-	
46N 1E 8-4	Qgd	U	10-14-55	-	-	-	44	-	32	-	-	-	-	8.0	-	-	300	-	535	-	
19-1	Qgd	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	115	-	-	
20-1	-	U	11- 8-55	-	-	-	93	-	22	-	-	-	-	15	-	-	462	-	813	-	
46N 2E 4-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	
45N 2W 31-1	Qgd	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135	-	-	
34-1	Qgd	M	10- -52	-	0	-	-	-	-	-	-	-	-	1.0	-	-	-	110	-	-	
45N 1W 29-3	Qgd	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	-	-	
45N 1E 13-2	Qgd	M	7- -55	-	12	-	-	-	-	-	-	-	-	2	-	-	-	120	-	-	
18-1	-	M	12-23-40	28	16	-	26	15	15	+	163	0	21	5	-	-	234	128	-	-	
45N 2E 3-1	-	U	10- 4-55	-	-	-	102	-	111	-	-	-	-	341	-	-	804	-	1380	-	Temp., 50.2. Appearance - clear
6-1	Qgd	M	5-23-51	-	12	-	-	-	-	-	-	-	-	-	-	-	-	80	-	6.6	
6-4	Qgd	M	5-10-51	-	10	-	-	-	-	-	-	-	-	3	-	-	-	100	-	7.2	
44N 6W 22-1	Qgd	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150	-	-	
44N 2W 5-7	-	M	-	-	.0	-	-	-	-	-	-	-	-	-	-	-	-	178	-	-	
6-4	-	M	-	-	.0	-	-	-	-	-	-	-	-	-	-	-	-	135	-	-	
7-7	Qgd	M	-	-	.0	-	-	-	-	-	-	-	-	-	-	-	-	136	-	-	
8-7	Css	M	-	-	.4	-	-	-	-	-	-	-	-	4.5	1.2	-	-	170	-	-	
18-1	Ols	U	10-26-55	19	.01	-	45	25	25	5.1	270	0	19	21	.5	0	277	215	498	6.7	Temp., 46.2; Color - 2
44N 1E 31-21	-	A	-	2	-	-	133	-	-	-	-	-	173	70	-	-	-	124	-	-	Well depth 576 ft.
31-21	-	A	-	-	-	-	186	-	-	-	-	-	147	79	-	-	-	119	-	-	Well depth 650 ft.
31-21	-	A	-	-	-	-	167	-	-	-	-	-	120	304	-	-	-	320	-	-	Well depth 1,360 ft.
31-21	Css	A	-	7.3	-	-	103	-	-	-	-	-	53	320	-	-	-	-	-	-	Well depth 1,500 ft.
31-21	Css	M	11-19-40	8	1.1	-	98	30	104	+	167	0	64	275	-	-	742	365	-	-	
31-21	Css	M	5- 1-48	-	-	-	-	-	-	-	-	-	-	275	-	-	-	350	-	-	
31-21	Css	M	4- -49	-	Tr.	-	-	-	-	-	-	-	-	280	2	-	-	350	-	-	
HIGHLY MINERALIZED GROUND WATER																					
47N 1E 9-1	Css	U	10- 3-55	1.4	1.1	-	150	36	970	14	23	6	63	1780	.6	-	3200	522	5620	8.5	Temp., 50; Color - 35
10-1	Qgd	U	10-11-55	-	-	-	746	-	726	-	-	-	-	2480	-	-	4620	-	7450	-	Temp., 49.02 Appearance - clear
10-1	Qgd	U	6- 1-56	12	.1	-	735	63	740	17	134	0	10	2540	.2	.1	4870	-	7800	7.9	Temp., 39; Color - 2; Al, 0.3
10-2	-	U	11- 8-55	-	-	-	524	-	535	-	-	-	-	1820	-	-	3440	-	5660	-	
21-2	Css	U	10-11-55	-	-	-	998	-	1190	-	-	-	-	3780	-	-	6500	-	10900	-	Appearance - rusty
46N 1E 8-3	Css	U	9-23-55	8.9	1.0	-	1396	252	2167	52	109	0	17	6387	-	-	10690	4519	17500	7.3	Temp., 49.8; Appearance - clear
44N 1E 14-1	Oss	M	6-19-35	4	0	-	132	82	800	+	311	0	30	1500	-	-	2710	655	-	-	
14-2	-	M	8-28-35	-	0	-	-	-	-	-	-	0	-	1350	-	-	-	-	-	-	Hydrogen sulfide present
SURFACE WATER																					
Spring at Sault Ste. Marie		M	6-17-26	15	-	-	552	30	19	+	-	-	1265	32	-	-	2294	-	-	-	
St. Mary's River at Sault Ste. Marie		U	9-22-06	11	.09	-	13	3.2	3.9	+	59	0	4.1	1.0	-	.2	63	46	-	-	
do.		U	10-22-06	8.7	.03	-	13	3.1	3.5	+	56	0	3.8	1.2	-	.2	61	45	-	-	
do.		U	11-22-06	5.9	.04	-	13	2.9	2.0	+	54	0	1.8	1.4	-	.4	54	44	-	-	
do.		U	12-20-06	7.2	.08	-	13	2.9	3.6	+	55	0	1.8	1.3	-	.3	58	44	-	-	
do.		U	1-22-07	4.7	.03	-	13	2.9	2.0	+	55	0	1.6	1.2	-	.4	53	44	-	-	
do.		U	3-22-07	12	.04	-	13	3.2	5.1	+	55	0	1.7	1.1	-	.4	68	46	-	-	
do.		U	4-20-07	12	.11	-	13	3.1	3.5	+	56	0	1.5	1.0	-	.3	64	45	-	-	
do.		U	5-23-07	4.8	.09	-	13	3.0	3.0	+	52	0	1.5	1.0	-	.6	57	45	-	-	
do.		U	6-22-07	4.6	.04	-	14	3.2	3.3	+	59	0	1.7	1.2	-	1.2	59	48	-	-	
do.		U	7-22-07	5.7	.05	-	12	3.0	2.8	+	58	0	1.5	1.0	-	1.2	55	42	-	-	
do.		U	8-22-07	5.3	.05	-	13	3.1	2.9	+	60	0	1.6	1.1	-	.5	66	45	-	-	
do.		M	11-26-54	1.7	-	-	12	2.6	4.3	+	58	0	2	-	-	.0	52	42	-	-	Temp., 42; Color - 5
Charlotte River, T. 46 N., R. 1 E.		M	6-30-26	25	7	-	20	6.7	-	-	72	-	8.7	3.9	-	-	195	82	-	-	Coll. in sec. 21.
do.		M	7-15-26	25.6	-	-	20	6.7	-	-	72	-	8.7	3.9	-	-	195	82	-	-	Coll. in sec. 21.
do.		M	7-15-26	26.4	-	-	25	7.2	-	-	100	-	8.6	4.9	-	-	238	95	-	-	Coll. in sec. 35.
Tahquamenon River, T. 49 N., R. 7 W.		M	7-19-26	5.6	-	-	17	4.7	-	-	45	0	6.2	3.0	-	-	150	60	-	-	
Waiska River at Brimley		M	8-14-26	8.0	-	-	20	5.9	-	-	66	0	1.3	2	-	-	135	65	-	-	